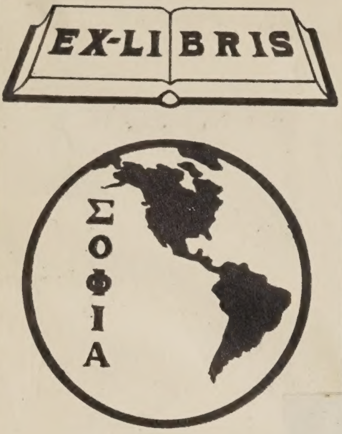

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FIRST ANNUAL REPORT

OF THE

ENTOMOLOGIST

OF THE

State Experiment Station,

OF THE

UNIVERSITY OF MINNESOTA,

TO THE GOVERNOR,

For the year 1895.

By Otto Lugger,
Prof. of Entomology,
University of Minnesota.

MINNEAPOLIS:
Harrison & Smith, Printers.
1896.

LETTER OF TRANSMITTAL.

STATE EXPERIMENT STATION,
UNIVERSITY OF MINNESOTA.
January 1, 1896.

To His Excellency, D. M. Clough, Governor of Minnesota:

SIR.—In accordance with the law, I have the honor to present herewith my first annual report as Entomologist of the Experiment Station of the University of Minnesota for the year ending December 31st, 1895.

Very Respectfully,
Your Obedient Servant,
OTTO LUGGER.

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1895-96

AN ACT TO PROVIDE THE ENTOMOLOGIST OF THE EXPERIMENT STATION OF THE UNIVERSITY OF MINNESOTA WITH THE MEANS TO DESTROY THE CHINCH-BUGS AND OTHER INSECTS INJURIOUS TO THE CROPS OF THE STATE.

Be it enacted by the Legislature of the State of Minnesota:

SECTION 1. It shall be the duty of the Entomologist at the Experiment Station of the University of Minnesota, as soon as practicable, after the passage and approval of this act, to procure the necessary equipment and assistance and proceed to combat chinch-bugs and other insect plagues, and to propagate such contagion or infection as is supposed to be destructive to chinch-bugs and other insects that are destructive to crops in this state; such contagion or infection shall be propagated at the State Experiment Station, and in such quantities as may be necessary to supply the farmers of this state with the same when required, and shall be furnished to them free of charge, and distributed under such rules and regulations as may be adopted by the Entomologist.

SEC. 2. That the expenses of combatting such insect plagues and the propagation of such contagion or infection, and the procuring of the necessary equipment and assistance therefor, shall be paid by the state out of the moneys hereby appropriated by this act.

SEC. 3. The Entomologist shall on or before the first of January in each year, make a report to the Governor of the results of his experiments and expenditures incurred under the provisions of this act.

SEC. 4. That the sum of five thousand ($5,000) dollars, or as much thereof as may be necessary, is hereby appropriated from the moneys in the state treasury belonging to the general revenue fund not otherwise appropriated, for the carrying out of the provisions of this act for the fiscal year ending July 31st, 1895, and annually thereafter, and the State Auditor is hereby directed to draw his warrant or warrants upon the State Treasurer for such sum or sums in favor of such person or persons as the Governor shall in writing indicate and approve as entitled to the benefits of this act, and the same shall thereupon be payable out of the appropriation hereby made.

SEC. 5. This act shall take effect and be in force from and after its passage.

Approved March 25, 1895.

(Signed) D. M. CLOUGH.

(S. F. 353. H. F. 372.)

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FINANCIAL REPORT.

1895.			No. of voucher.	Amount.
May	27.	To street car fare, meals, memorandum books.....	1	$ 2.55
	28.	Minneapolis to St. Louis..........................	2	19.00
	29.	Meals, bus, baggage, hotel in St. Louis............	3	8.95
	31.	Street-car fare, bus, baggage, meals, fare to Kirkwood, Mo., to Champaign, Ill., to Danville, to Wooster, Ohio, hotel..........................	4	25.85
April	2.	Sleeper, meals, fare to Cleveland, to Buffalo, hotel	5	15.25
	5.	Meals, fare to Ithaca, hotel, fare to Rochester, hotel	6	22.00
	9.	Street-car fare, baggage, postage, expenses of R. H. Pettit	7	14.45
	9.	Cash to R. H. Pettit for material in Ithaca.......		5.00
	9.	Fare to Albany, baggage, hotel.....	8	9.00
	10.	Fare to New York, hotel, fare to Baltimore, hotel	9	14.30
	12.	Hotel in Baltimore, bus, baggage..................	10	21.25
	20.	Fare to Washington and return, meals, hotel.....		9.10
	20.	Fare to Minneapolis, incl. sleeper to Chicago......	11	33.50
	24.	Meals, sleeper to Minneapolis......................	12	8.85
May	1.	Salary and labor for April..........................	13–17	220 00
	1.	Two cabinets..	18	250.00
	1.	Books...	19	45.00
	1.	5 gallons molasses and keg.........................	20	1.25
	1.	Express and freight.................................	21	19.79
	13.	Jars..	22	2.79
	13.	Postage...	23	5.00
	15.	Freight...	24	7.57
	25.	Express and freight.................................	25–26	1.15
June	1.	Salary and labor for May...........................	27–31	220.00
	3.	Express...	32–35	4.80
	10.	Expenses of R. H. Pettit at Cornell................	36	42.60
	6.	Trip to New Ulm, hotel, meals......................	37–38	14.00
	10.	Canvass...	39	16.50
	10.	Express	40	1.65
	10.	Trip of agent to Rochester..........................	41	5.85
April	30.	To bill of Bausch and Lomb for instruments, etc.	42	290.78
May	16.	" " " " " " "	43	106.50
	31.	" " " " " " "	44	177.50
June	6.	" " " " " " "	45	103.75
May	3.	To bill of Wyckoff, Seamans & Benedict for typewriter	46	97.50
	3.	do for cabinet and chair	47	35.00
	20.	Spraying machinery........................	48	41.02
	22.	To bill of Husby Bros. for infection boxes, etc....	49	114.65
	23	To bill of Held & Gruenhagen for jars, oven, gasoline, etc...	50	49.98
	10.	To Noyes Brothers & Cutler for insecticides.......	51	8 20
	1.	To bill of John A. Schlener & Co. for stationery...	52	32.87
	2.	To bill of Fred Kempfer for glassware.............	53	16.55

1895.			No. of voucher.	Amount
	2.	To bill of F. M. McAllister for Camera, etc	54	58.45
June	6.	To bill of O. H. Peck, for chemicals	55	4.37
May	28.	To bill of O. Heidemann for illustrations	56	55.00
June	11.	Bill of Koehler & Hinrich for fluid beef, etc	1	12.00
	15.	Express	2–4	6.20
	17.	Journal N. Y. Entomological Society	5	6.00
	19.	Postage	6	10.00
	25.	Flannel, Canton, Muslin, Swiss	7	1.48
	25.	Bill of L. Malchow for pots	8	8.00
	25.	Bill of J. H. Smith for globes and chimneys	9	2.90
	26.	Bill of T. H. Mallory for pots	10	1.25
	26	J. A. Schlener & Co. for pamphlet-cases	11	6.00
	26	Bill of O. H. Peck	12	.72
	24.	W. H. Gruenhagen for labor, 34 doz. jars, gasoline, etc	13	52.80
	22.	Bill of Bausch & Lomb for triplets, microtome, camera, etc	15	166.45
	30.	Bill of R. H. Pettit for street-car fare, postage, meals, etc	16	3.65
	28.	Salary and labor for June	17–22	430.00
	28.	Freight for gas machine	24	22.11
	28.	Express	25	1.25
	28.	Trip of J. M. Drew to Forrestville	26	9.81
	29.	Bill of Lindig Bros. for meat	27	8.00
	30.	Otto Heideman, for illustrations	28	55.00
	30.	Express	29	1.47
	30.	Collins Bi-ocular microscope with accessories	30	225.00
July	11.	Bill of Richards & Co. for rubber tubing	1	8.10
	11.	Bill of Whitall, Tatum & Co. for glassware	3	16.95
	11.	Bill of Bradlee Whidden for books	4	2.00
	12.	Bill of Brooks Bros. for lumber for gas machine	5	6 57
	11.	James Bladon & Co., material for gas machine	6	3.20
	12.	Bill of Noyes Brothers & Cutler for tin boxes, etc.	7	3.30
	7.	Bill of O. H. Peck for chemicals	8	23.94
	22.	Bill of Otto Heideman for illustrations	9	55.00
	22.	S. E. Cassino for book	10	2.60
	15.	Bill of Wm. Boss for labor on gas machine	11	44.00
June	29.	Bill of G. E. Stechert for books	12	32.89
July	10.	Stamps	13	10.00
	1.	Bill of G. E. Stechert for books	14–15	20.16
June	29.	Bill of Noyes Brother & Cutler for formalin	16	1.60
	22.	Bill of Detroit Heating and Lighting Co. for gas machine	17	312.25
July	15.	Bill of Flood & Vincent for book	18	7.74
	30.	Trip to Taylor's Falls, postage, etc. (R. H Pettit).	19	13.60
	30.	Salary and labor for July	20–25	430.00
	31.	R. H. Pettit for glassware	26	116.00
	22.	Bill of G. E. Stechert for books	27	177.05
				$4,576.26

TABLE OF CONTENTS.

Page.
Letter of transmittal........ ii
Act to provide the entomologist with means, etc........ iii
Financial report........ iiii
Table of contents........ vi
Introduction........ 1
Chinch-bugs........ 3
  Vulnerable points in their habits........ 5
  Diseases of insects........ 9
  The chinch-bug disease........ 15
  Production of spores on a large scale........ 18
  Laboratory experiments and experiences........ 20
  Distribution of spores in 1895........ 23
  Status of chinch-bugs at the present time........ 25
  Map showing distribution of chinch-bugs........ 26
  Different ways of spelling chinch-bug........ 27
  Bogus insecticides........ 28
  Bark-beetle disease........ 31
  Bacterial disease of grasshoppers in Colorado........ 34
  Bacterial disease of cabbage-butterflies........ 36
  Disease of tent-caterpillars........ 38
Migratory locusts or grasshoppers........ 39
  The lesser migratory locust........ 42
    How the eggs are laid........ 43
  The Pellucid locust........ 48
  Grasshoppers near Taylor's Falls and elsewhere........ 50
  Parasitic enemies of migratory locusts........ 55
    The red mite........ 55
    Tachina-flies........ 57
    Bee-flies........ 58
    Blister-beetles........ 59
  Other enemies of locusts........ 61
Potato-beetles........ 61
  The Colorado Potato-beetle........ 61
    Paris-green........ 65
      Dry application........ 66
      Wet application........ 66
    London-purple........ 67
    White arsenic........ 67
Blister-beetles........ 68
Cabbage insects........ 70
  Imported Cabbage-butterfly........ 71
  Native Cabbage-butterfly........ 71
    Remedies........ 74
    Enemies........ 76
  The Zebra-caterpillar........ 78

Page.
- The Cabbage Plusia.......... 78
- The Cabbage Plutella.......... 79
- Other enemies.......... 79

Saw-flies.......... 81

Currant insects.......... 83
- Imported currant-worm.......... 83
- Native currant worm.......... 85
  - Enemies.......... 85
  - Remedies.......... 85
- Currant-louse.......... 87
- Grapta butterfly.......... 87
- Four-lined leaf-bug.......... 87
- Currant-borer.......... 88
  - Remedies.......... 91

Lepidopterous borers.......... 92
- Maple-tree borer.......... 92
- Plum-tree borer.......... 93
- Red-oak borer.......... 93
- Ash-tree borer.......... 94
- Other borers.......... 95

Leaf-roller of box-elder.......... 97
  - Parasites.......... 99
  - Artificial remedies.......... 99

Apple-tree Leaf-folder.......... 100

Sweet-corn moth or tassel-worm.......... 100
  - Life-history.......... 101
  - Enemies.......... 103
  - Remedies.......... 104

Rosin-weed caterpillar.......... 104

Parsley butterfly.......... 106
- Remedies.......... 108

Box-elder bug.......... 108

Bean-fly.......... 111
- Remedies.......... 113
- Wheat-stem maggot.......... 114

Hessian-fly.......... 117
  - Remedies.......... 118

Aphides or plant-lice.......... 119
  - Remedies.......... 122

Scale-insects or bark-lice.......... 123
  - Remedies.......... 124
- Common mealy-bug.......... 126
    - Remedies.......... 126
- Cotton Maple-Scale.......... 127
    - Remedies.......... 127
- Willow or cottonwood-scale.......... 128
    - Remedies.......... 128

Page.
The White-scale of the cactus.............................. 129
The Elm-tree white-scale.............................. 129
The Eccentric scale of the elm.............................. 129
Machines for applying insecticides.............................. 130
Application of wet insecticides.............................. 131
Application of dry insecticides.............................. 136
Cut-worms.............................. 136
List of owlet-moths taken on sugar in St. Anthony Park.............................. 144
Explanation of illustrations on plates.............................. 152
Index.............................. 153

INTRODUCTION.

As soon as the act given on page iii was approved by his Excellency, Governor D. M. Clough, and after the entomologist had been authorized and empowered to inaugurate the work contemplated by House File No. 372, he entered upon the duties therein defined, The necessary equipment and assistance were secured soon after the approval of the act, and energetic measures were taken to combat the chinch-bugs and other noxious insects so numerous in 1894, and so threatening for 1895. The results of his labors are given, in part, in the following pages.

There remains for the entomologist the pleasant duty of expressing his sincere thanks to all persons that have aided him in this work, but especially to his assistant, Mr. Rufus H. Pettit, who has assisted faithfully in both the laboratory work and the preparation of this report, and to Hon. Tams Bixby, who has always shown the greatest interest in the work, and has assisted the entomologist in many ways. The fine illustrations on the plates were made by Mr. Otto Heidemann, of Washington, D. C., who combines the artistic and entomological features in these drawings. The Chicago, St. Paul, Minneapolis and Omaha, and the St. Paul and Duluth R. R. Companies also deserve thanks for their kindness in furnishing free transportation over their roads whenever such was asked.

INSECTS INJURIOUS IN 1895.

OTTO LUGGER.

CHINCH-BUGS.

It is not necessary to give in detail the life-history of this insect, as it has already been given in Bulletin No. 37, published by the Agricultural Experiment Station, which can still be had upon application. Yet as remedies depend very largely upon an intimate knowledge of this life-history, the essential points will be given. Fig. 1 illustrates the chinch-bug in its different stages:

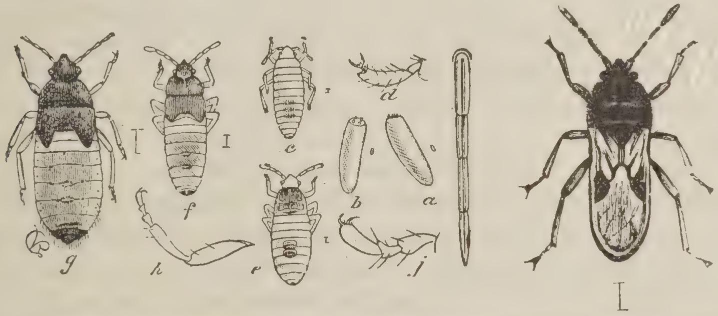

FIG. 1. Different stages of the Chinch-Bug, showing Egg, Larva, Pupa and Adult. After Riley.

The Chinch-Bug, sometimes called the "Mormon Louse," has received numerous other names, as may be seen by the list of names by which it was mentioned in letters received in 1895. It has from time to time caused immense losses; for instance, Illinois alone lost in 1871 ten millions of dollars, while the total loss for the six central states in that year amounted to thirty millions of dollars. The estimated loss in 1874 was sixty million of dollars, and that of 1887 six hundred millions. In the same year Minnesota alone lost $6,790,821 in the counties marked in the map, while the loss in others equally badly infested was not given.

The adult bugs winter in various positions, and can be found in large numbers hidden between the stools of timothy and wild grasses. Rubbish of all kinds, but chiefly that of hedges, wind-breaks and along the edges of woods, as well as corn-fodder, logs and even loose bark and stones, offer shelter. In spring these bugs revive, and move to the nearest fields of small grains. Here they deposit their eggs, and careful investigations by means of the microscope have shown that at least 225 eggs can be deposited by each female. These small eggs, of which thirty arranged lengthwise in a line cover about one inch, are not all deposited at the same time, but only from 15 to 20, which accounts for the fact that we may find adults, pupæ and larvæ of various sizes all belonging to the same brood; this also accounts for the fact that it is difficult to demonstrate that the chinch-bugs have only two annual broods. Judging from the rapid increase in numbers farmers not unfrequently claim that this insect has at least one hundred annual generations! The eggs of the first brood are deposited at the roots of such plants as wheat, rye, barley and grasses; plants of the above kinds, that grow nearest to the winter quarters of the insects, are first selected. The fact that grain-fields near edges of woods, or upon slopes, suffer most, is thus readily accounted for. But since the bugs fly at this period, fields suitable for them, i. e. fields with a poor stand of plants, are selected and utilized. A good farmer, or one that is an agriculturist and not a pirate, a man that feeds his land as he expects to be fed by it in return, never suffers as much from chinch-bugs as an ignorant and slovenly one. When the plants infested by chinch-bugs no longer afford liquid sap, the bugs of the first generation have to search for fresher material, and as they prefer to migrate on foot large armies are formed which move towards the nearest corn fields. They move most generally on foot, though many of the bugs already have wings, and in certain exceptional conditions will use them. After reaching the corn the eggs for the second generation are deposited, which mature in time, and produce the insects that search, on foot or wing, for sheltered places in which to winter.

VULNERABLE POINTS IN THEIR HABITS.

When we consider the life history sketched above, we find that a practical person will be very apt to discover some habits that could be utilized to kill large numbers of this pest. Considering the fact that these bugs find shelter under all sorts of rubbish, leaves, etc., it appears assuredly feasible to attack them there with good results. Clean farming, then, is not only godly, but an excellent remedy against that insect, and against many others. Let every farmer do his share of the work by not permitting any rubbish to accumulate upon his farm. In our usually dry autumns all rubbish will burn well. Such material should be raked together in rows; this should be done before the bugs search for shelter, and as they surely will find such rows, they will not be slow to appropriate them for winter quarters. Later, rubbish and bugs can be disposed of by fire. This work should include the clearing and cleaning of the edges of the woods, of fences and fence-corners, of hay-stacks and straw-stacks, and of wind-breaks; in fact, no rubbish should be permitted to remain upon the farm, for no rubbish means no shelter for the bugs. Besides this all the taller grass should be burned over; in fact let the fire be anywhere and everywhere excepting where it might be dangerous. The burning of dead foliage upon fields, meadows and prairies in former times accounted, to a great extent, for the absence of many injurious insects at present only too common.

We know that chinch-bugs prefer certain plants and dislike others; they prefer millets, for instance, and almost invariably attack this plant when found in the infested region, while flax repels them. It seems that barley is their second choice, then wheat, and later in the season corn. Winter rye frequently escapes harm, as it usually ripens too early, though a great deal depends upon the season, and rye may be destroyed by preference. Chinch-bugs do not like oats. This does not mean, however, that oats will invariably escape their ravages. On the contrary, if more suitable food should be scarce, chinch-bugs consider oats good enough for them, and act accordingly. By sowing millets very early, and having it above ground before the bugs leave their winter shelters, they will assuredly find and appreciate it, and will settle there in very large numbers. Of course the owner of such millet cannot expect to grow both a crop of millet and of bugs, but will be forced to sacrifice the former to kill the latter. Just before the millet becomes too hard for the insect, it should be cut and left upon the soil. The bugs remain upon it for some time before realizing the necessity of migrating, and this delay should be utilized to burn millet and bugs.

Another point in the life-history of these bugs is their love for warmth and dryness, and consequently their selection of fields offering bo'h. Chinch-bugs prefer sandy soil or poorly cultivated soil simply because in such fields the plants are small and of irregular growth, thus permitting the sun to strike the soil directly, it not being shaded by the foliage. Fields well covered with plants, and consequently soils well shaded, are not attractive to these insects. A good farmer will not utilize such soils, but will enrich the sandy soil to such an extent as to produce a strong and uniform stand of plants; nor will he cultivate poorly a good soil; neither will he be a robber of the soil by continuing to remove crops year after year without returning something to the soil in form of manure to keep up its fertility. A good farmer will escape many losses by insects and other pests where a poor farmer would suffer. Good farming, and clean farming, should be the motto over every farmer's door. Poor farming means also a rank growth of weeds, and mainly of the different species of pigeon grasses, which in themselves are a great attraction to chinch-bugs.

Another point in favor of the good farmer, or of one who feeds the soil generously, is a return of the thankful soil in form of strong and vigorous plants; plants which can withstand the attacks of injurious insects much better than the weak plants growing on a starved soil.

As long as it is the aim of the farmer to grow upon the biggest scale possible only one kind of crop, just that long noxious insects will be numerous, or even increase still more in numbers. The reason for this is so self-evident that it is not necessary to explain. If more diversified farming was the rule and not the exception, as it is at present, fields containing the same kinds of plants would be more or less widely separated by fields containing other kinds of plants, and insects would not find it so convenient to multiply without let or hindrance. Such fields of cereals, separated by other fields containing other crops, would soon reduce the numbers of many insects, and among them those of the chinch-bugs. Of course this would mean, perhaps, more work, but it would also mean less trouble and better returns for the labor expended.

When we consider the method in which the bugs of the first brood migrate from the dry plants first infested to the future green food in the corn fields, we are struck with the fact that nearly all bugs, whether large or small, migrate on foot, and that even the great majority of the winged ones do not form an exception by using their wings, Of course, under certain conditions a small percentage take to their wings; but this is the exception and not the rule. Armies of insects migrating on foot, and moving slowly and in the same direction, should offer us many opportunities to oppose or to stop them entirely. This very fact of migrating on foot is the weak point in the life-history of the chinch-bug, where we can, with a little foresight, overcome them. Many different methods may be adopted, depending mainly upon the character of the ground over which the insects have to pass. In our own state the agricultural soils are usually quite free of rocks and stones, excepting certain localities where they abound, but where, in consequence, but little grain is grown. By making, between grain and corn field, a ditch several feet in depth, immense numbers of bugs can be captured and killed; in fact nearly all that travel on foot. But in dry summers such ditches will have sides composed of baked and hard soil, and would offer but a slight hindrance to the moving army beyond extending their trip over a little greater distance. It is therefore necessary that the sides of such a ditch should be smooth and that its bottom should be very dusty. The latter is very easily managed by tying together a bundle of twigs, with the leaves still adhering, and by dragging this bundle repeatedly through the ditch until the desired conditions have been made. The spade should be used to rectify any defects in the smooth sides. If such a ditch can not be made, one or more very deep furrows should be plowed, and by using bundles of twigs their bottoms should be kept very dusty. Very fine dust will perform the work most thoroughly. As already mentioned, it is almost impossible for a bug to cross such a dusty strip. Many modifications of this method are possible and will suggest themselves to the thinking farmer. Even a strip of plowed land, made perfectly level with a disk-harrow, and thoroughly rolled by a heavy roller and made dusty, will do wonders. All these methods have two ends in view: to stop the progress of the bugs, and to collect them in large numbers in a limited space, so that they may be killed. This latter can be done in various ways. If ditches are used, a little straw scattered in the bottom will soon be crowded with bugs; in fact, piles of straw seem to confuse the traveling bugs and retard and retain them for some time. The straw can be burned by adding a little kerosine oil. Or, by means of a post-hole augur, holes can be made every ten or fifteen feet, into which the bugs will collect or into which they may be swept. By closing such holes where filled with bugs, and making other holes, or by killing the bugs in the holes with kerosine oil and cleaning them afterwards with the augur, the bulk of the army can be captured and disposed of. As the bugs will not cross coal tar, the edges of furrows or ditches towards the fields to be protected should be covered with this material, and none of the insects could leave the trap. This coal tar can also be used even without a ditch or furrow, but will not be so effective; yet in certain and extreme cases it may be the only method that can be used in time. By pouring a broad line of this material upon the neutral zone between the fields, and by keeping its surface fresh, the bugs may be held in front and can be trapped in holes made for this purpose. If all such measures have been neglected, or if the bugs have already reached the outer few rows of corn, the plants in them should be cut down in such a way that they form more or less continuous piles upon the ground. The bugs, being starving, will not leave these stalks for some time, but will continue to find their sustenance upon them. This, for quite a while, prevents their moving to the next rows of corn. The bugs can be killed in very large numbers by burning dry straw between the piles of corn cut down. A little kerosine oil, or any other substance that burns well and makes a dense smoke, will make a very pleasing addition to the entertainment. Knowing the principle to be applied, every thinking farmer ought to know how to apply it to the best advantage upon his own fields. The very fact that the bugs are retarded for a long time upon the heated surface of the ground is sufficient to kill a large number.

It seems strange that sensible farmers, who have been told again and again, should fail to make use of such a very simple and cheap remedy, simply because it requires some extra work. And yet this work is required to be done at a time when other farm work is not so very pressing. If these methods were only generally and conscientiously followed, there would be no need to apply other remedies; and not only would the corn be saved, but in saving it the second brood of chinch-bugs would be very materially reduced in numbers, and in a short time the chinch-bug would cease to be the destructive insect it now is. As this method is such a good one it bears repetition: all that is required is a thoroughly dusty surface, best in a depression especially made for that purpose, and that this dusty surface should be attended to diligently, so that repairs can be made whenever necessary. A ditch or furrow left unattended will be made in vain.

Although most of the direct remedies—the insecticides now in general use—will prove of but little value, we should except the kerosene-oil emulsion, which can be used very successfully in certain cases. If the migrating bugs have reached the outer rows of corn, and almost hide these plants by their presence, this material will prove very effective; and as it will cost less than 75 cts. per acre, it should be used much more generally. The emulsion should be well made, and it will be best to use the one made after the Hubbard formula, which is given in the article on leaf or plant-lice.

DISEASES OF INSECTS.

Diseases of insects can be found at most any time and place. The disease of the common house-fly, fig. 2, which fastens the dying flies to our window-panes late in summer and during the autumn, will serve as an example of one very widely distributed. All of these diseases are produced either by bacteria, like many of the diseases of man, or by fungi, some of which resemble moulds found upon old bread, milk, etc. A figure of a bacterial disease is given in fig. 3. This is the Pebrine of the silk-worm. A healthy worm and a diseased one are shown, and on the left side some of the bacteria causing this disease. The disease-producing fungi reproduce by means of small fruiting bodies known as conidia or spores, which answer the purpose

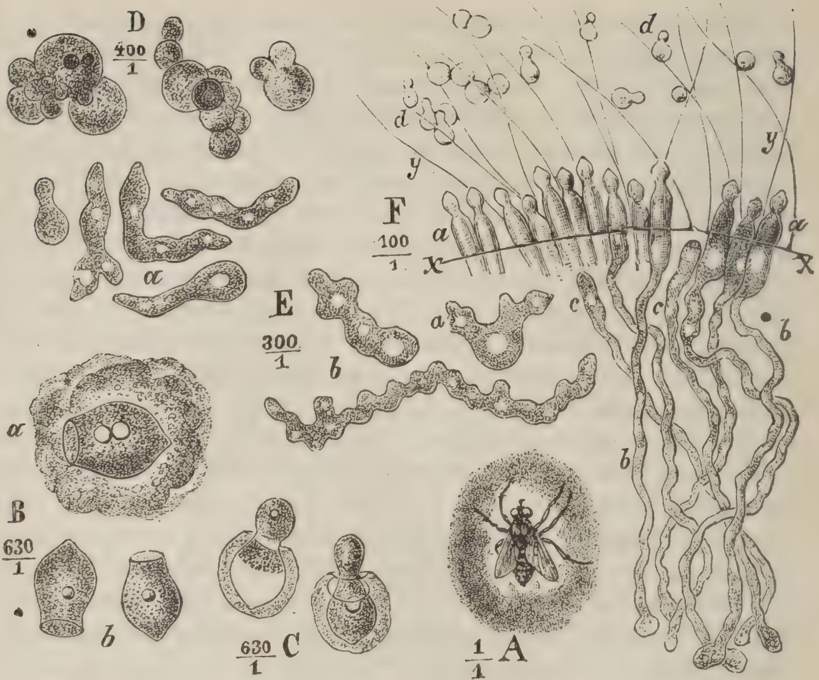

FIG. 2.—*Empusa muscæ*, Cohn. *A*, a dead fly killed and surrounded by a halo of spores. *B*, spores; *a*, surrounded by protoplasm; *b*, without the same. *C*, germinating spores forming secondary spores. *D*, Empusa cells forming tubes. *F*, partly diagrammatic representation of the fructification; *x*, the skin of the fly; *y*, hairs of the fly; at *a* the ends of the hyphæ breaking through the skin and bearing spores; *b*, the hyphæ-tubes still in the body; *c*, tubes not yet reaching the skin; *d*, spores thrown off and adhering to hairs, some already forming secondary spores. After Brefeld.

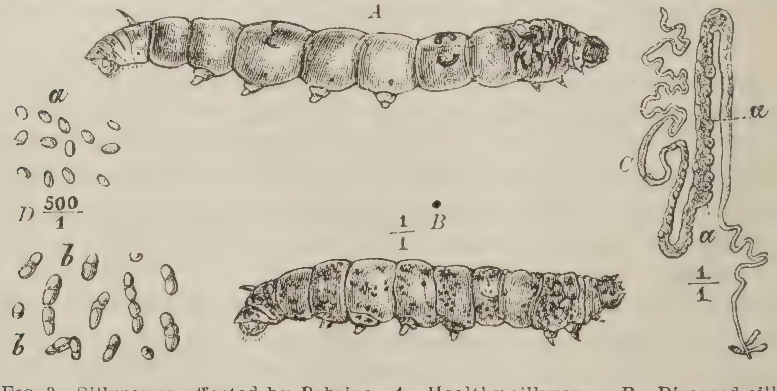

FIG. 3.—Silkworms affected by Pebrine—*A*. Healthy silkworm. *B*. Diseased silkworm. *C*. Spinning glands of a diseased silkworm, with knotty swellings. *D*. *Micrococcus ovatus* Lebert, the fungus causing disease; *a*, single cells; *b*, cells in the act of self-division. After Lebert.

of seeds in more highly organized plants. The practical value of a disease-producing fungus depends largely upon its ability to grow on other material than insects, or in other words, on the ease with which it can be artificially cultivated, aside, of course, upon its fatal character to the insects themselves. It also depends very largely on the habits of the insects on which it grows. Thus social insects are more liable to epidemics than solitary species, for in social species a constant contact with the diseased objects as well as with the other members of the same colony greatly facilitates the spread of the disease. This explains, in part, why a disease will spread much more rapidly, and work more effectually, when insects occur together in large numbers, than when few and scattered. The same thing occurs when an epidemic of yellow fever or cholera sweeps through our land. How much more quickly and fatally it works in our cities than in thinly populated regions! Some of these diseases seem to force their victim to wander about, and thus spread them in all directions. Thus grasshoppers attacked by the **Grasshopper-fungus** (*Empusa grilli* Fres.), invariably climb some tall weed or grass, and cling to it long after death.

Figure 4 shows a grasshopper (*Melanoplus bivittatus* Say.), which has been attacked by the fungus and killed after it had climbed to the top of a plant. The figure shows well the frantic efforts of the grasshopper to cling to its support. This peculiar effect of the disease enables its spores to infect a much wider area, as they can from this elevated position fall on the food of the grasshoppers as well as on the grasshoppers themselves. This fungus has also the power of throwing its spores to a considerable distance. A chinch-bug when it feels the first effects of the *Sporotrichum*, usually seeks some cool, shady

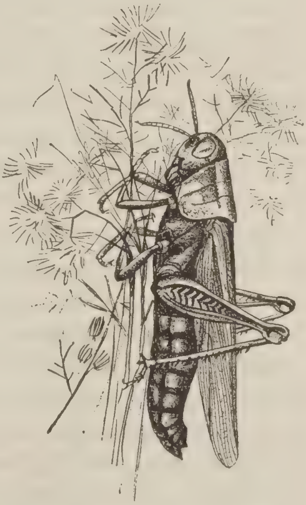

FIG. 4.—*Melanoplus bivittatus.* killed by a fungus. Original.

spot under a clod of soil, and there dies in the spot usually chosen by the healthy bugs for a quiet place to shed their old skins. The wire-worms attacked by a disease caused by *Isaria anisopliœ* Metch. are usually found in bunches of loose vegetable matter, in which they die. Possibly they gather there after being attacked; at any rate the fungus-growth usually spreads from the body of the wire-worm to the vegetable matter, on which it grows and spreads. These actions of the insects aid in spreading epidemics found among them. Many epidemics among insects are useful to man, if noxious insects are the sufferers, and it is possible by artificial means to cultivate and increase the spores, which cause them, to almost any extent. But this is about all that man can do, as he is unable to produce at the same time all those conditions that are in favor of the parasite.

The manner in which an insect is attacked by a fungus-disease is usually through the skin or breathing-pores, or else by eating the pores that found their way to its food. In either case the minute spore germinates or puts forth a slender germ-tube, which penetrates the skin of the wall of the intestines or stomach, and grows into the body-cavity. Here it develops by taking food from the juices of the body; sometimes branching freely and often breaking up into short segments, until it eventually fills part or all of the body of the insect with a more or less firm mass of interlaced fibres. Figure 5 shows the manner in which one of the cabbage-worm diseases destroys its victim. The death of the insect has generally occurred by this time and it only remains for the fungus to provide for the reproduction of its kind. This it does by the growth of the threads through the skin and the production, on the outside, of spores or conidia born in various ways, sometimes in loose fluffy masses of threads, as in the case of the chinch-bug disease, sometimes in a more elaborate growth, which, if the insect is subterranian, usually reaches up above the surface of the ground; sometimes the spores are borne close to the body on the ends of threads which barely project through the skin. This is the case with the fungus of the common house-fly, as may be seen in the illustration fig. 2. These spores gain access to other insects, and the cycle of growth is repeated until winter or unfavorable conditions prevent its further progress.

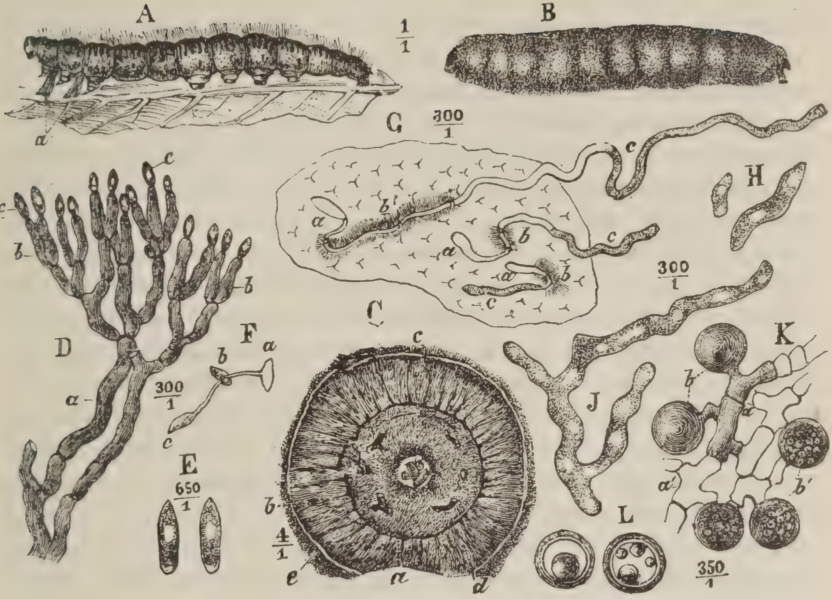

Fig. 5.—*Entomophthora radicans* Bref. *A*, caterpillar of *Pieris brassicæ* killed by it; *a*, the hyphæ growing out from it. *B*, the same at a later stage, and entirely enveloped by the fungus. *C*, cross-section through *B; a*, cuticula of caterpillar; *b*, tracheæ; *c*, remains of food—all the soft parts of the caterpillar are replaced by mycelium threads, which have, at *d*, penetrated through the skin, and formed spores, at *e*. *D*, *a*, fruit-hyyhæ; *b*, basidia; *c*. spores. *E*. single spore. *F*, a single spore *a*, producing a mycelium thread with secondary spores *b* and *c*. *G*, a piece of the skin, with germinating spores *a*, penetrating the skin at *b*, and growing in the interior at *c*. *J*. branched mycelial thread. *K*, mycelial threads bearing resting spores; *a*, filled with protoplasm; *a'* emptied; *b*, developing, and *b'* mature resting spores. *L*, mature resting spores with a thick envelope and fat-drops within. After Brefeld.

When an insect is found infested with a disease with which it is desirable to experiment, the first step is to procure, if possible, pure cultures on some artificial substance. This has to be done in various ways; sometimes a method that will succeed with one disease will utterly fail with another. The ordinary method is to make a dilution-culture as follows: three glass tubes, each containing a small amount of nutrient agar, are placed in a water-bath and heated until the agar is melted. The tubes must have been previously plugged with cotton and thoroughly steamed for several days to destroy any living organisms present in them. The agar is a jelly-like substance, which is fluid when heated, but which solidifies when cooled below 42 degrees centigrade. When the agar in the three tubes is melted they are cooled down to 43 degrees, and a small portion of the material containing spores is introduced on a flamed platinum needle into the first tube. The tube is then well shaken, the cotton plug is re-inserted and the top burned off to kill any organisms on the rim of the tube. One or two drops are now poured from this first tube to the next which is shaken, and the process is repeated between tubes number two and three. It will be seen that of the material taken from the insect, most is in tube number one, less in number two and least of all in number three. It really amounts to a twice repeated dilution, whence the term dilution-culture. The contents of the tube must have been kept all this time in a water-bath at 42 degrees centigrade. Each tube is now removed, and its contents poured into a sterilized shallow, flat dish of glass, called a Petrie-dish, which has an overlapping cover of glass. The agar on being poured into the cool Petrie-dish quickly hardens, and any organisms present are fixed in position in the thin layer of jelly-like agar which contains nourishment for their growth. The Petrie-dishes are now labeled and placed in a moderately cool place for a day or less. They may be placed on the stage of a microscope and studied at any time, and the germination and growth of the spores thus watched to the time of fruiting, when new spores are produced. In the course of one or two days minute growths of a filmy radiate form are usually to be seen scattered over the plates. Each separate spot is produced ordinarily by a single spore or germ, so that each growth is pure in itself. These spots or colonies grow in a definite manner, which is constant for any one species. Sometimes they produce beautiful white circular growths of fluffy threads which in some species turn green with the production of conidia; in some species the growth is small and star-shaped, or occasionally it is flat, but more often raised in relief and rounded, while not uncommonly the growth stops at any of these stages and can not be induced to proceed, a sure sign that the method of growing them is wrong. (See figure 8, plate 2.)

Scattered through the plates, and often occupying nearly the entire surface, will be seen growths of common moulds and bacteria, which have been introduced with material from the insect. To obtain a pure culture from the dilution-culture on the plate, a platinum needle is heated white-hot in a gas-flame and, after cooling, touched to the conidia or spores born by a single colony or circular growth on the surface of the agar. The needle is then carefully carried to a piece of potato placed in a glass tube, and prepared as follows: an oblong slab or stick of potato is placed in a test-tube and half covered with water. A number of these tubes are then placed in a crate of woven wire and thoroughly steamed for one or two hours in a steam sterilizer. This is repeated for three or four days for the purpose of killing any organisms present, when, after a certain interval, the tube is ready for use. A day or so after being inoculated with spores from the dilution-culture, there appears a small, raised, white, loose growth, somewhat like that seen on agar. This usually spreads, and the extent to which this proceeds depends on the species of the fungus grown. The color may remain white, or change to yellow or green or some other color, and the potato on which it grows may be colored in various ways; purple, dark-brown, orange and cream color are those usually seen. Part of the potato may send up long columns of interlaced threads, which sometimes grow one or two inches in length, and in some species become branched. These various forms and colors produced during growth are great aids in determining the species in question, as they are, within certain limits, constant to the species. From such pure-cultures any amount of the fungus desired can be propagated.

THE CHINCH-BUG DISEASE.

The fungus used during the past season in combatting the chinch-bugs was obtained from several sources, that most generally and successfully used was obtained from a white grub found at Ithaca, N. Y.* Other material was obtained from Professor Snow of Kansas State University; some from a culture made by Professor Forbes of the Illinois State University; still other material from *Sporotrichum globuliferum* obtained from a carabid beetle at Ithaca, N. Y., and also some from chinch-bugs killed in Minnesota in 1894. As the form first mentioned was the one most generally and successfully

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*This species (*Isaria vexans* Pet.) was described in Bulletin No. 97 of Cornell University, Agricultural Experiment Station. It is considered an *Isaria* because of the production of true Isaria-sporophores in artificial cultures.

used, a description of that will serve, with slight variation, as typical of all of them.

The specimen from which this form (*Isaria vexans*) was obtained, was found in the insectary at Cornell University. It was completely covered with a felted white coat of mycelium, bearing patches of the creamy-white conidia. A microscopic examination showed the fine anastomosing threads bearing minute spherical conidia or spores in clusters, which as they increase in size by the constant addition of conidia, assume the form of compact semi-spherical heads identical with those seen in the plate culture. When this disease attacks the chinch-bug it covers it entire body, with the exception of the legs and some small parts which project from the snow-white covering (Fig. 6). When grown in artificial plate-culture the development is as follows: the nearly spherical conidia becomes swollen, and produces a slender germ-tube, which grows in a sinuous line, Fig. 7, *h*, branching occasionally, and producing many long cylindrical conidia in the agar. These are born at the ends of filaments, and each spore is successively pushed aside by that next produced, resulting usually in a cluster of spores placed side by side (Fig. 7, *o*). Branching soon commences, and septa are often present just below the bases of the branches. At the end of about three days the growth appears above the agar in loose, cottony filaments, each colony becoming circular in form and finely radiate. After one more day the conidia appear. Short sterigmata bear one or two conidia on short pedicles. (Fig. 7, *l*, *k*.) These conidia increase in number and the sterigmata lengthen and multiply until at the end of a week large heads are formed. (Fig. 7, *m*.) The threads anastomose freely (Fig. 7, *n*.), In places where the colonies are crowded they sometimes assume a stellate form. Fig. 8, Plate 2,

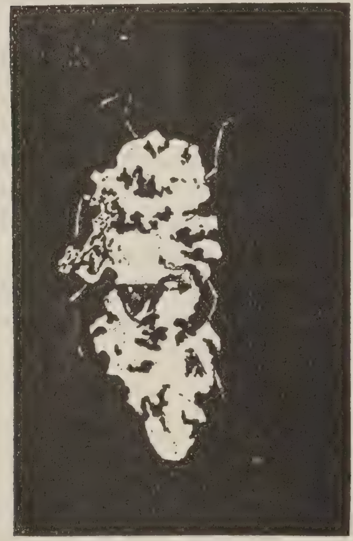

FIG. 6. Bug covered by mycelium of Sporotrichum.

shows the appearance of a plate culture on two different days, on the right the growth four days after sowing, and on the left eight days after.

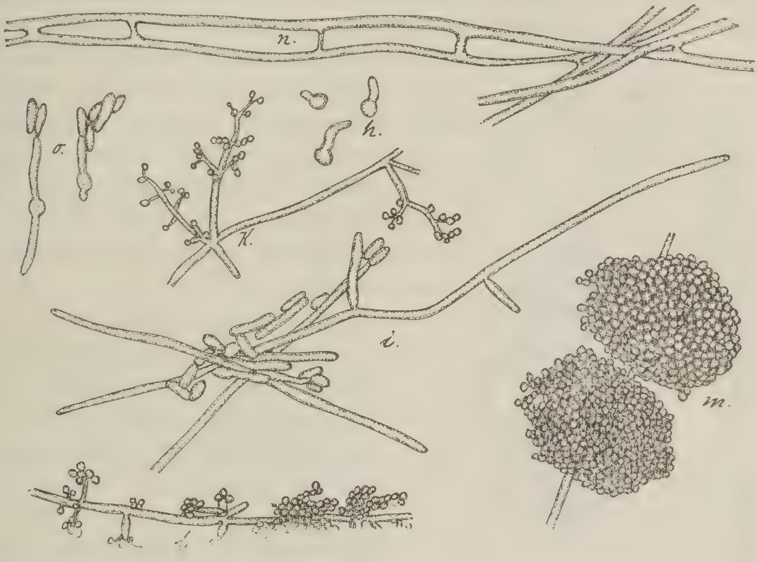

Fig. 7. *Isaria vexans*, showing *h*, germinating spores; *o*, production of cylindrical spore. *i*. the same, later; *l* and *k*, production of first conidia; *m*, heads of conidial; *n*, anastomosing threads. Original.

On potato the growth spreads over the entire surface in a felted layer, afterward becoming densely covered with a farinaceous, creamy-white layer composed of colorless conidia. The threads by interlacing and growing away from the potato often produce Isaria-sporophores. One tube produced ten, ranging from two to four mm. in height. They are usually clavate in form, sometimes being three mm. in diameter at the apex, tapering to one mm. at the base. Sometimes these Isaria-sporophores cling to the glass and become flattened; such often grow to the length of eight mm. In old cultures, wherever the mycelium touches the glass, it is seen to be of a bright buff color.

When grown in small flasks, where the supply of food is larger, the development goes on further. The potato is colored a distinct purple. After about twenty days the entire surface becomes coated with a creamy-white covering of conidia. Many crowded radiating growths of threads appear, spherical in form, and having a creamy-white color and velvety surface. In five or six days the velvety pile collapses gradually, and from three to fifteen cylindrical processes are produced in its place. These present a color more intensely creamy than the balls from which they sprung. They develop into long, slender, and usually clavate sporophores, generally simple, though sometimes branched. They occasionally reach the length of 2.5 mm.

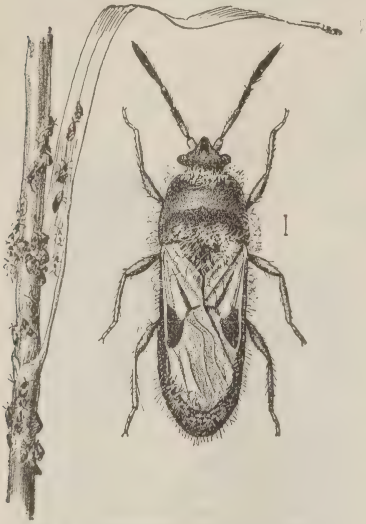

FIG. 9. Diseased chinch-bugs; enlarged specimen shows fungi penetrating through skin and covering it; others in natural size killed by the disease. Original.

Chinch-bugs, when attacked by this fungus, become uneasy, refuse to eat, and finally become quiet and die. Shortly after this the characteristic felted growth bearing the heads of conidia appears on the outside. Fig. 9 shows a chinch-bug, greatly magnified, which has been killed by the fungus. The fine thread-like growth on the outside is the mycelium of the fungus.

PRODUCTION OF SPORES ON A LARGE SCALE.

The propagation of the fungus was carried on in fruit jars on a very extensive scale. The two-quart Mason jar, first used by Prof. Forbes, having a zinc cap lined with porcelain, is very convenient for this purpose. The porcelain lining of the screw cap is removed, and a short tube of tin, about one and one-half inches long and three-fourths of an inch in diameter, is soldered in the center of the cap (Fig. 10, Plate I). This tube holds the plug of cotton with which the jar is closed. When the jar is ready to be charged the cap is removed and the jar about one-fourth filled with a mixture of corn-meal and beef broth, made by boiling beef in water until most of the nutriment is extracted.

This mixture is of about the consistency of dough. The jar is then placed, together with many dozens of others prepared in the same way, in a large tin steamer or sterilizer, (Fig. 11, Plate I), to be steamed for four or five hours. It is then taken out and the cap removed in order to break the now solid mass of steamed meal into fragments about the size of a walnut. This is to allow the fungus-growth to penetrate more easily and to grow throughout the entire mass. It is now thoroughly steamed during four or five days for six or eight hours daily. This thorough steaming is for the purpose of kiiling off the myriads of vegetable organisms present, in other words to perfectly clean or sterilize the ground in which the fungus is to be grown. The cotton plug allows free access of air, but stops all bacteria and spores of fungi from falling in, or otherwise contaminating the meal. This is very important, for if any other organisms are present they are sure to spring up at a later period and crowd out the disease-producing form.

The spores are now introduced into the sterilized jar as follows: A platinum needle, made by inserting a piece of platinum wire in a glass rod, is placed in a gas jet and heated white hot to destroy all germs that may be clinging to it, after which it is touched to a pure culture, either in a tube or another jar, and from thence into the prepared jar through the tube in the cap, the cotton plug having been removed for this purpose. The plug is replaced and the jar laid on its side in a shady but fairly warm place. In the course of a few days a small white spot of fluffy threads will be seen where the needle touched the meal. Soon this growth of fluffy mould spreads over the entire surface, penetrating into the interstices between the pieces of meal, and uniting the whole in one mass of fungus-growth, which soon takes on a floury or powdery surface of creamy-white, caused by the production of conidia or spores. If now the jar be opened a pleasant odor resembling that of mushroons is noticeable.

After the culture has been allowed to dry for a short time it is removed from the jars and cut into small pieces, to be placed into small round tin boxes. In the course of a day or so the growth spreads over the freshly cut surfaces, making a smooth even growth of creamy-white. It is now ready to be sent to the place where it is to be used for infection.

Many attempts were made to raise the fungus in jars not provided with the tube and plug. Sometimes they were successful, but on the whole it was found very difficult to prevent contamination by other fungi and bacteria. Many jars of potatoes were used. They were prepared by placing small pieces of potato in a jar with a little water and then steamed as with meal. The fungus grew less vigorously on this, and when grown was in a much less convenient form, as the potato never became firm unless too dry for the fungus to live.

LABORATORY EXPERIMENTS AND EXPERIENCES.

Experiments to test the virulence of the fungus in the laboratory were made, although these have been carried out and varied many times in various places. On June 5 a number of bugs were placed in three glass moist-chambers, which contained a layer of soil on the bottom and a supply of fresh wheat leaves. The bugs in one cage were dusted with the form originally brought from Ithaca *(Isaria vexans)*, one with material obtained from Prof. Forbes, and the third glass chamber was left as a check and was not intentionlly infected. After four days many bugs were dead in both the infected cages. All showed the presence of the fungus by the characteristic white felted growth of mycelium bearing the spores. After two days more the fungus appeared on the bugs in the check cage as well, and the experiment was discontinued as most of the bugs in the infected cage were killed and showed the fungus. The bugs in the check cage must have been affected by the spores in the room, which were not present in a large quantity, thus requiring more time to become apparent.

The fact that the disease is often present ready to break out when the conditions are favorable is proven by the following experiment. On May 28 a moist chamber was partially filled with moist soil and on this was sprinkled a liberal supply of green wheat. Some chinch-bugs were inserted and the chamber closed. After one week most of the bugs were dead and covered with the fungus.

Several attempts to spray the fungus on the bugs, by mixing the spores with water, were made. On June 10 a large two-quart culture was mixed with two and a half gallons of water and well shaken. The mixture was then put in a knap-sack sprayer and sprayed on a small field of wheat, in which the bugs were moderately plentiful. After over two weeks no effect was visible.

On June 18 about five acres of wheat were sprayed with the spores of the fungus in the following manner: a two-quart culture was shaken and rubbed with water until it was mixed as well as possible. The spores did not mix very well but appeared to float as soon as the shaking was stopped. One or two jars of the mixture were then mixed with a barrel of water and this was pumped on the plots in a small solid stream to make it reach the ground. A barrel of water was used to the acre. No visible effect followed this spraying, and the failure in the first attempt made it appear that the spores were not mixed thoroughly. A small amount of water was taken from the spray while in the field and from it a dilution-culture was made. Not a single growth appeared from this, showing the entire absence of spores in the water when it was pumped on the field, which was owing to their inability to mix with it. A turbid appearance of the water seemed to show the presence of quantities of spores, but this appearance undoubtedly came from the meal in the culture, the spores having been buoyed to the surface as with oil. It is very likely that a mixture might be obtained by the use of milk or some viscid substance, as glucose or flour.

During the time of both applications a severe drought prevailed;this was followed by some slight showers, after which the disease appeared, killing off the bugs.

On July 2 an attempt was made to spread the fungus by means of corn-meal. A sack of corn meal was mixed with water to the consistency of dough and cooked. The contents of six pint jars of the fungus were then mixed with it, and this mixture was carefully spread over about an acre of wheat infested with chinch-bugs. The weather, unfortunately, became very dry about this time, so that the fungus completely dried up.

An experiment in propagating the disease in large infection boxes was made as follows: On July 30 a large wooden infection box was placed in the cellar, and a layer of earth two inches in depth spread over the bottom. Several stalks of growing corn were then laid on this, and a number of chinch-bugs were then enclosed. The contents were now dusted with spores of *Isaria vexans*, sprinkled with water and closed. The box was subsequently sprinkled with water on alternate days. On Aug. 7 some of the bugs were dead and covered with the fungus. About a teacupful of bugs were added at this time. On Aug. 9 very many were dead and covered with the fungus, and by Aug. 13 nearly all had been killed.

The presence of the disease-producing fungus in the laboratory was a source of great annoyance, interfering very seriously with the breeding of insects of various sorts. It was almost impossible to get any insects to mature. as the disease attacked them almost indiscriminately. A dead grasshopper, while drying upon a spreading-board, was invaded with the result shown in Fig. 12, Plate 2. Out of several hundred bag-worms (*Thyridopteryx ephemeræformis* Steph.) less than a dozen matured. The disease produced in the laboratory rooms an epidemic among insects from which there was no escape. Fig. 13, Plate 2, shows one of these bag-worms, killed by the fungus.

Generally speaking these and other experiments showed that the *Isaria vexans* will grow profusely upon all dead insects, and that it will kill also very many others that may be somewhat weakened by confinement. In case of the bag-worms a large number were crowded together in a rather small breeding-cage, which may account for their weakened condition. But many healthy insects, when introduced into the room, soon caught the disease and died. In this manner even mosquitoes and the common house-flies were killed in large numbers. Another fact became also very plain, i. e., that the fungus grew very rapidly upon dead chinch-bugs, which were covered with a dense growth in three or four days. The spores are not easily killed by a high temperature. and some that were exposed to almost 140 degrees F. showed their vitality when brought in contact with feeble chinch-bugs, soon killing them and covering their dead bodies with the characteristic white shroud. A large number of spores are at the present time exposed to our "gentle zephyrs" to see if they can stand this treatment as well.

None of the diseases that kill chinch-bugs can be called a true remedy, as we can do but one part of the work, while climatic conditions must do the other. It is easy to produce any amount of fungi producing such diseases, but we can not produce the necessary weather to make it effective. All such diseases require two distinct conditions, i. e., a fair amount of moisture to make such plants as fungi thrive well, and a lowered vitality of the bugs to be attacked by the disease. Under artificial conditions we have control over both, and can consequently produce from a small amount of the fungus, a very large number of diseased and fungus-covered dead bugs. But when we introduce this material among the healthy bugs in our fields we loose control over the necessary conditions, and have to depend upon the weather that may be prevaling at the time. If this is in favor of the death-dealing fungi the introduction of a disease will be a success; if not it will do but little good. In other words, if the disease is introduced when the weather is favorable, good results will follow; if dry, none may be expected.

The disease is chiefly active during the warmer portions of the season, and makes but slow progress during the time that the bugs hibernate, though autumn rains and warm spells during the winter promote the growth of fungi causing them. Throughout the region in which the spores of *Sporotrichum* were introduced during the summer of 1894, and where they did but little good on account of the almost unparallelled drouth, the disease killed the great majority of bugs during the exceptionally warm and open early spring, and also later in the spring of 1895, which was very favorable to such a disease.

DISTRIBUTION OF SPORES IN 1895.

The demand for diseased chinch-bugs in 1895 was great, but not nearly as great as would have been desirable, at least not early in the season. To show the interest taken it will be best to state how many boxes filled with spores of the disease were mailed to the different counties, since in doing so the distribution of the chinch-bugs in 1895 is also given. In a few counties, in which the bugs were not found, some farmers evidently took time by the forelock by laying in a stock of such spores.

Anoka county	22	Boxes to	12	Farmers.
Benton county	8	" "	6	"
Blue Earth county	80	" "	48	"
Brown county	195	" "	136	"
Carver county	306	" "	244	"

Crow Wing county	4	Boxes	to	2	farmers.
Chisago county	16	"	"	12	"
Cedar county	2	"	"	1	"
Dakota county	120	"	"	70	"
Dodge county	182	"	"	58	"
Douglas county	18	"	"	8	"
Fillmore county	270	"	"	165	"
Faribault county	12	"	"	4	"
Freeborn county	36	"	"	10	"
Goodhue county	220	"	"	65	"
Hennepin county	148	"	"	62	"
Houston county	92	"	"	23	"
Kandiyohi county	66	"	"	18	"
Le Sueur county	188	"	"	52	"
Lincoln county	4	"	"	1	"
Meeker county	240	"	"	72	"
McLeod county	135	"	"	47	"
Murray county	10	"	"	2	"
Martin county	12	"	"	4	"
Mower county	92	"	"	36	"
Morrison county	4	"	"	1	"
Nicollet county	314	"	"	86	"
Olmsted county	138	"	"	46	"
Otter Tail county	28	"	"	6	"
Pope county	8	"	"	3	"
Renville county	35	"	"	9	"
Rice county	122	"	"	34	"
Redwood county	22	"	"	6	"
Steele county	36	"	"	9	"
Sibley county	468	"	"	112	"
Stearns county	265	"	"	63	"
Scott county	210	"	"	48	"
Stevens county	4	"	"	1	"
Todd county	42	"	"	9	"
Wabasha county	166	"	"	42	"
Waseca county	98	"	"	10	"
Washington county	4	"	"	1	"
Winona county	258	"	"	62	"
Watonwan county	35	"	"	8	"
Wright county	170	"	"	35	"
Yellow Medicine county	2	"	"	1	"
Total	14,877			1,941	

Besides these boxes several thousand were expressed to the owners of mills in the infested regions. Many farmers that called at the office were supplied with preserve-jars filled with the spores of the chinch-bug disease. Farmers in a number of other states also applied for material, and a number of boxes were mailed to Colorado, Illinois, Indiana, Iowa, Kansas, Montana, Michigan, Missouri, Nebraska, New York, Ohio, Oklahoma and Wisconsin. Generally speaking farmers waited too long in applying for the spores, and permitted the very suitable wet portion of spring to pass by without trying to introduce the disease. As long as no actual damage to the growing grain could be observed, farmers did not apply for assistance, and only when almost too late, or during dry weather, did they ask for spores.

STATUS OF CHINCH-BUGS AT THE PRESENT TIME.

The season of 1895 has been a very good one for farmers, and they have sustained but small losses by insects, very much smaller than is usually the case. In most counties the ground was kept in excellent condition by seasonable rains during spring and summer, and all plants soon became strong and remained healthy until a bountiful harvest repaid the diligent farmer and gardener for all his labors. These conditions prevailed in most of the counties, though the desired and much needed rain failed to come in some few, or failed to come in time.

Wherever there was a sufficient amount of rain early in the season the chinch-bug disease appeared, and did such good execution that later, or when the small grains were harvested, no bugs were left to form the well-known armies that invade the corn-fields. This was almost invariably the case, so that, generally speaking, these counties are practically free from this pest. Those regions, however, in which no sufficient amount of rain gladdened the thirsty soil, and in which the crops suffered severely on that account, still contain immense numbers of chinch bugs, though even there the disease killed off large numbers. As we had a very dry autumn the insects that escaped death from the disease are very likely in a healthy condition, and will doubtless survive the winter and be ready to multiply again in the spring. If, however, we should again have a rainy spring there is but little doubt that the disease will appear again in all regions in which it left behind numerous spores. Moisture alone, even excessive moisture, will not always kill the eggs and young larvæ of the chinch-bugs, as these can be immersed for many days without being killed. But a wet season will rapidly lower the vitality of the chinch-bugs, and dispose them to contract the disease.

Judging from a large number of letters the writers were well pleased with the results of spreading spores among chinch-bugs. In many cases the disease spread rapidly and effectively, in others the results became not apparent until rain assisted. Of course it would be folly to claim that the disease was always spread by the introduction of such spores, and it is also possible that it would appear simply because the climatic conditions were in its favor. Whatever may be the reason of its appearance, so many farmers believe in the effectiveness of an introduction of spores causing the disease, that the state can well afford to continue this work, as the expenses of producing spores on a large scale are but small.

MAP SHOWING DISTRIBUTION OF CHINCH-BUGS.

The map shown in fig. 14 was made by Mr. Vincent Bailey to indicate the distribution of the chinch-bugs during the last two years, as well as during the year 1887, when farmers lost as much as $6,790,821 by this insect alone. The region infested in 1887 is indicated by section-lining, that in 1894 by a dark line giving the extreme western and northern distribution, and that in 1895 by crosses in the counties invaded. It will be seen that as a very general rule the chinch-bugs did not invade the region in which only pines and other evergreens grow, but that all the more southern counties, which are well wooded with deciduous trees, are invaded. It will also be seen that farms located in the open prairies have in no case suffered from these insects, but that those regions that were formerly simply rolling prairies but are now more or less covered with patches of timber between the farms, are the very headquarters of such insects. In former years this region, bounded on the west with dotted lines, was annually burned over, thus preventing the growth of timber; this has ceased, and the country is now occupied with numerous thrifty farms. Since the cessation of prairie fires the chinch-bugs find suitable shelters, which they do not in the open prairies, or at least not yet. But as these prairies are gradually occupied by farms, and as wind-breaks are grown everywhere, they will also in time offer winter-quarters for chinch-bugs, and thus these insects will gradually occupy a larger area.

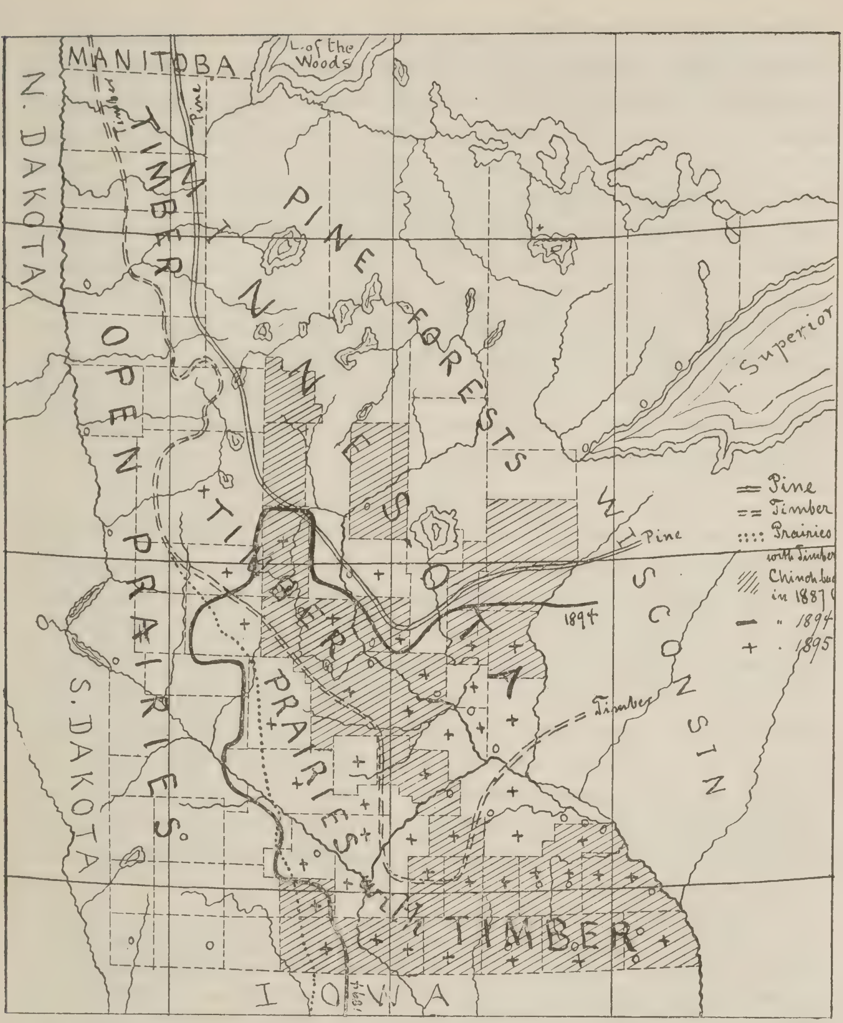

Fig. 14.—Map of Minnesota showing distribution of pine forets, of deciduous trees, of prairies with timber and open prairies. Also distribution of chinch-bugs in 1887, 1894 and 1895 Original.

DIFFERENT WAYS OF SPELLING CHINCH-BUG.

An animal or plant that is considered beautiful, strong, valuable or important usually receives a large number of popular names. If the converse is true, the chinch-bug must be a very popular insect, as is shown by the following list of sixty-six names by which it was mentioned in letters received from farm-

ers during 1895: Chingsbogs, Chinch Buck, Chinsh bugs, Chinge-bugg, chingh bug, chingebugs, chintch bugs, chick bug, chinc bug, Chings bugs, Chince bug, chinge Bugs, Chints bugs, Ching bugs, Chincebugs, ChickBugs, Chins bugs, Ginge Buck, Chinsh bug, Chidgbucks, Chinsbug, Cinch bug, Chinsee bugs, Chinz bugs, Chinge bug, Chinck Bugs, chinzbug, Chinsch bug, chince bug, chintz bug, chich bug, Chinck bugs, Chinche bugs, schinsboks, chin bug, Cinch bugs, Cinche bug, Cinsh bug, bugs, Chings bugs, Cinge Bugs, Shingebogs, chint bug, Chins Chints bug, Chintx bug, Chinth bugs, chinchbug, Chinche bugs, Chingbugs, Chinchbuck, Chink bugs, Ckinck bugs, Chinckbug, ching bugs, Chinch bugs, Chinxh bugs, Chinch bug, Chincsbug, Chints bugs, Chinch buck, chintch bug, ching bogs, Chingsbox, Chintg bug, Chitz bug, Chinsh bug.

BOGUS INSECTICIDES.

There are not only "quacks" that pretend to allay all human sufferings by some medicine which they alone can compound, but there are also other benefactors of the human race who have discovered some "cure-all" against all enemies of plants, diseases included. In some few cases these persons are cranks who really believe in the remedies that they have invented, though as a very general rule they are simply swindlers after money. It is difficult to decide to which class of benefactors Mr. Olavus C. Langseth belongs. After reading the following letters the readers may decide for themselves, also whether they are willing to pay money for quack-medicine or not.

Prof. Otto Lugger,
St. Anthony Park, Minn.

Dear Sir:—I have received the enclosed letter relative to a certain powder, claimed to be patented, etc. Please give me what information you can on this subject and return the letter with your answer, as soon as may be.

Yours truly,

(Signed.) KNUTE NELSON, Governor.

Executive Dep't St. Paul, June 1, 1894.

In reply to this letter it was stated that without knowing the composition of the insecticide it would be impossible to decide about its value, but that chinch-bugs could not be poisoned by powders of any kind, simply because these insects had not biting mouths.

The writer procured from Red Wing a large sample of this wonderful material, with the view of having it analysed. It is sold as "The American Soil Renewer" and "Insectieide," patented December 25th, 1888. Prof. Harry Snyder, the chemist of the Experiment Station, very kindly made an analysis of the "Insectieides," of which a copy is given.

St. Anthony Park, Minn., etc.
University of Minnesota Experiment Station.
Chemical Laboratory.
(Station No. 2095.)

ST. ANTHONY PARK, Minn., April 30, 1895.

To Professor Otto Lugger: the sample of American Soil Renewer and Insecticide received in January, 1895, has been found to have the following composition upon analysis:

Common salt ($NaCl$)	79.61 per cent.
Land plaster ($CaSO_4$)	4.50 per cent.
Hygroscopic moisture (H_2O)	4.22 per cent.
Organic matter and traces of other material	11.67 per cent.
	100.00 per cent.

The organic matter contains veratrine, the alkaloid found in common white hellebore. There is only a little of this material present.

Reported May 1, 1895. HARRY SNYDER, Chemist.

No more was heard from Mr. Langseth until April 6th, when the following letter was received:

PROF. OTTO LUGGER,
State Experiment Station,
St. Anthony Park, Minn.

Dear Sir.—Herewith enclosed find a letter from Mr. Langseth, which I submit to you for consideration. Mr. Langseth's post-office address is Red Wing.

(Signed) D. M. CLOUGH,
Executive Dep't, St. Paul, April 6, 1895. Governor.

The following is a copy of Mr. Langseth's letter to the Governor:

Your Excellence!—It is not more than right, that I should have something to say about the chinchbugs; having a patent on the sure destruction to them and other insects and it has been tried here and proved the best of success in the township of Zumbrota. There was millions of the bugs destroyed and many witnessed it, even gentlemen from the twin cities. Spent yesterday in Lake City and sold over 3,000 lbs. of my compound. At present I have no money to advertise, as it costs me 25 cents a line of the true merits, while we read Prof. Lugger's humbug concerning the deceased bugs in every paper and languages.

Ex-Governor Nelson helped me get the patent, while in Washington and I think it is worthy of being considered.

Yours Respectfully, O. C. LANGSETH.

As Mr. Langseth claimed to have his "Soil Renewer and Insectiede" patented through Ex-Governor Nelson, while that gentleman was in Washington, and as Mr. Nelson in his letter simply stated that Mr. Langseth claimed to have a patent, the writer was curious to probe the matter to the bottom, and he consequently wrote directly to the U. S. Patent Office. To his great astonishment he received the following copy of the patent:

UNITED STATES PATENT OFFICE.

Olavus C. Langseth, of Grand Forks, Dakota Territory.

INSECTICIDE.

Specification forming part of Letters Patent No. 395,065, dated December 25, 1888.

Application filed October 16, 1888. Serial No. 288,258. (No specimens.)

To all whom it may concern:

Be it known that I, Olavus C. Langseth, a citizen of the United States, residing at Grand Forks, in the county of Grand Forks, and Territory of Dakota, have invented a new and useful Composition of Matter to be Used for the Destruction of Chinch-bugs, of which the following is a specification.

My composition consists of the following ingredients, combined in the proportions stated, viz: ground ginger, one pound; salt, one pound. These ingredients are to be thoroughly mingled and put up in merchantable packages.

In using the above-named composition, if the season be dry, the powder may be added to sixteen gallons of water and applied immediately after the grain has been removed from the ground; but if the season be wet the powder may be spread upon the ground broadcast or by means of a drill or other suitable mechanical appliance, allowing the rain to dissolve the matter and impregnate the earth therewith.

The compound may be mixed with grain and applied at seeding time, thus saving time and labor.

If the composition be used in liquid form, a sprinkler such as is used in cities in watering streets will probably produce the best results; but where such an one cannot be obtained, or if it should prove too expensive, a substitute may be improvised by attaching an ordinary garden or lawn hose to a faucet or hollow tube inserted near the bottom of a barrel mounted upon a wagon, cart, or other suitable conveyance.

By the use of this compound, either in liquid form or powdered state, every chinch-bug in a field may be destroyed, and ground impregnated with it will not be invaded by the pests.

What I claim, and desire to secure by Letters Patent of the United States, is—

The herein-described composition of matter prepared in merchantable packages ready for the user, to be used in the destruction of chinch-bugs in the manner substantiallly as set forth herein, consisting of ginger and salt in the proportions specified.

Witnesses: OLAVUS C. LANGSETH.
P. J. Bye,
Wm. Ackerman.

The composition patented is simply an "Insecticide" composed of equal parts of ground ginger and common salt!! Nothing is said about the "American Soil Renewer," which title is based upon the addition of a small amount of Land Plaster. Nor does this combined soil renewer and insecticide as sold contain ginger, but simply traces of a little white hellebore, the only material that can be considered as at all useful against certain insects.

A quotation from a letter received from the Chief Entomologist of the U. S. Dep't. of Agriculture will show in what esteem this and other patented insecticides are held in that department:

> Thank you for the specifications of the patent remedy. I do not know what we are to do about these things. On several occasions we have entered formal official protests at the Patent Office but they have apparently received no consideration. The immortal words of Walsh, written in 1867, are as applicable to-day as then: "Long live King Humbug! He still feeds fools on flapdoodle!"
>
> Yours sincerely,
> (Signed.) L. O. HOWARD,
> Washington, D. C., May 10th, 1895. Entomologist.

Mr. Langseth very feelingly remarks in his letter to the Governor that the newspapers charge him 25 cents a line to advertise the true merits of his "Insectieide." But as he claims to have sold 3000 lbs. of it in Lake City alone he should be able to pay a little for advertisements, as he had a clear profit of at least $600 in that transaction alone. I hope Mr. Langseth will be satisfied with the above advertisement, which will not cost him a cent.

BARK BEETLE DISEASE.

(*Isaria tomicii* sp. nov.)

On June 19, the writer found three small beetles belonging to the genus *Tomicus*, lying close together in their burrow in a pine tree. They had been attacked and killed by a fungus-disease related to that of the chinch-bug. The beetles, about 3 mm. long, were partially covered with a dense, white, felted coat of mycelium, the fungus breaking forth from the junction of the prothorax with the abdomen, and from under the wing-covers (Fig. 15). From one end of each beetle there arose a slender Isaria sporophore, about 5 mm. long, and 1 mm. in diameter. In one case the sporophore is clavate, in another flattened and tapering. Two sporophores arise from one of the beetles. A microscopic examination shows the sporophore and the felted mass at the base to be covered with clusters of conidia resembling those of *Sporotrichum globuliferum*, but measuring usually from $1\frac{3}{4}$ to $2\frac{1}{4}$ microns in size.

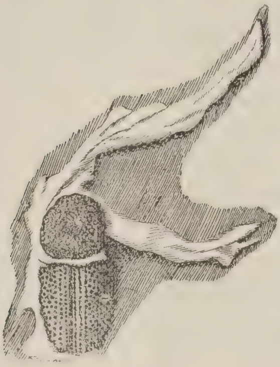

FIG. 15.—Bark-beetle attacked by *Isaria tomicii*. Original.

Description.—A dilution-culture was made and pure cultures started on potato. In agar-agar plate-cultures the development is as follows: in about one day after sowing the conidia become swollen and put out one, two, or three slender germ-tubes, fig. 16, *a*, which rapidly lengthen, and after two days become branched to a considerable extent. Vacuoles are numerous at this period, fig. 16, *b*. After about four days the threads appear above the surface of the agar, anastomosing freely both above and below the surface, fig. 16, *c*. After about a week conidia are borne on the threads, in clusters with a verticillate arrangement. Short offshoots from the main threads bear whorls of from two to six short branches, which in turn bear whorls of either sterigmata or branches; these branches bear at their extremities groups of from two to six or more flask-shaped sterigmata which bear the hyaline conidia at their apices on short, minute pedicels, usually in clusters of from two to eight, fig. 16, *d* and *e*. These clusters grow and produce more branches until, after about eleven or twelve days, they appear like dense, rounded balls (Fig. 16, *f* and *g*) borne on the main threads, after the manner of *Sporotrichum globuliferum*. The separate colonies have, by this time, grown until they are beautiful, circular, fluffy masses raised from the surface of the agar. They are from 5 to 10 mm. in diameter. In places where they are crowded the growth is not strongly raised from the surface of the agar, but quickly becomes covered with clusters of conidia causing it to appear farinaceous. In more favorable places, less crowded, the growth rises in strong circular colonies, which are loose and fluffy, and occasionally rise 5 or 6 mm. from the substratum.

The colorless conidia are usually spherical; they are all spherical when first born, but some of them become somewhat irregular or oval from the pressure of contiguous conidia in the large heads. They measure 1¾ to 2¼ microns, sometimes reaching 3 microns when oval.

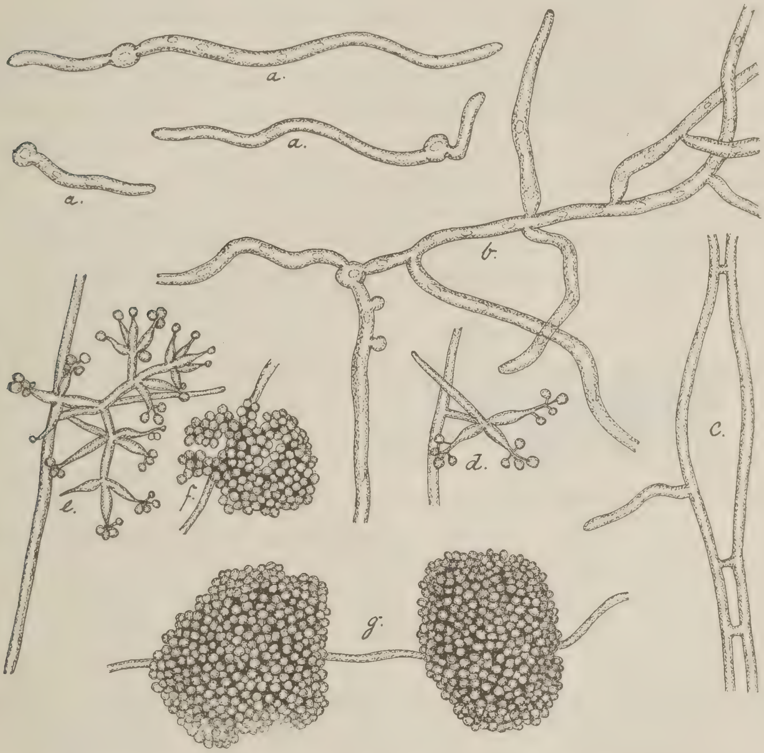

Fig. 16.—*Isaria tomicii*. *a*, germinating spores; *b*, the same two days later; *c*, anastomosing threads after four days; *d*, *e*, formation of clusters of conidia, after one week; *f* and *g*, mature clusters of conidia after twelve days. Original.

On potato the growth quickly spreads over the surface in a loose, fluffy, white growth, which rests on the surface of the liquid and causes the potato to turn a beautiful purple color, very deep and intense. The growth soon increases until the diameter of the tube is entirely filled and the threads force their way upward for a distance, becoming slightly creamy in color. No Isaria-sporophore has as yet been observed. In half-litre Erlmeyer flasks, in which pieces of sterilized potato were placed, no sporophores were produced, and the growth was essentially the same as in the test-tube.

BACTERIAL DISEASE OF GRASSHOPPERS IN COLORADO.

In the issue of June 28 of the Brighton (Colorado) Register was an account of a bacterial disease, which was said to be destroying the grasshoppers of Colorado in great numbers.

Professor Gillette, the Entomologist of the State Experiment Station, was at once applied to for specimens. Through his request a box of grasshoppers was received on July 7 from Mr. Geo. R. Lee. The grasshoppers contained in it were brown in color, and very offensive to the smell. They invariably clung to the tops of Alfalfa branches on which they had died. The greater part of those sent belonged to the large species of grasshopper known as the two-striped locust (*Melanoplus bivittatus* Say). (Fig. 17.) A specimen, which had the appearance of having recently died, was selected, and a small piece of the digestive tract was taken through a slit in the thorax. A dilution-culture was made from this, as well as from other parts of the body. Several species of bacteria were found and pure cultures made of them.

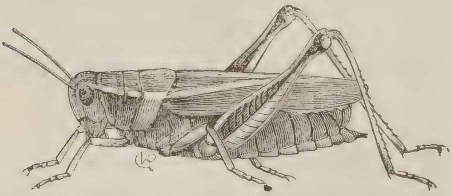

FIG. 17. Common native two-striped locust. Natural Size. After Riley.

Numerous attempts were made to spread the disease to our native grasshoppers. On July 9 two flower pots were filled with growing sod and a number of healthy grasshoppers enclosed. Some of the dead ones from Colorado were then shaken in a flask with water, which was sprinkled, with some of the dead hoppers, on the food and living grasshoppers in these pots. No effect was seen after several weeks. Some of the grasshoppers died, but did not exhibit the peculiar smell of the diseased ones, and showed no inclination to climb upon anything before dying.

Six species of the bacteria found in the bodies of the dead grasshoppers from Colorado were grown in flasks with bouillon to obtain a sufficient quantity of these parasitic plants. A strong growth was obtained in three days, when they were mixed and taken toTaylor's Falls. Here a large number of migratory grasshoppers were collected and shaken with the bouillion-culture, after which they were liberated. No effect was seen after a month. A number of grasshoppers were brought from Taylor's Falls to the laboratory; they were divided into lots of about twenty each, and each lot was placed in a wire netting in which were pots of growing rape and grass. Six of these cages were sprinkled with six bouillon-cultures, and two cages were similarly prepared but not infected. The enclosed grasshoppers died gradually and as fast in one cage as in another, including the check-cages which were left uninfected. None of those that died exhibited any signs of the disease.

On Aug. 7 thirty grasshoppers were placed in six cages and each set of five infected with one of the six species used in the previous instance. Each grasshopper was rubbed along the spiracles with bacteria from a pure culture; a small portion was also placed in the mouth of each. The grasshoppers were *Melanoplus femur-rubrum* and *Melanoplus bivittatus.* They were placed in a cage containing growing rape. Two cages were prepared similarly to these, but the grasshoppers contained were not infected. In the course of ten days they were all dead, having died with equal rapidity in all the cages, including the two check-cages, but none of them showed signs of disease.

On Aug. 23 another box of dead and living grasshoppers came from Professor Gillette. A cage of wire-gauze was placed over a large piece of sod, and about fifty living and healthy grasshoppers introduced. Over this cage was placed another wire-gauze cage in which were the dead and living grasshoppers from Colorado. Water was now sprinkled daily over the upper cage from which it percolated through the dead bodies of the diseased hoppers upon the bodies and food of those underneath. This experiment was carried on in a cool shady place, where the best conditions for spreading the disease were approached as nearly as possible. The grasshoppers in the lower cage died gradually, but exhibited no signs of disease, and showed no desire to cling to the wire netting, or to climb upon things as do those attacked by the disease.

This inability to introduce a disease which was raging only a few hundred miles away among the same species of grasshoppers that we have here, shows how truly dependant on climatic conditions are most of the diseases of insects as well as those of higher animals. The germs of disease were undoubtedly brought in contact with the grasshoppers many times, but they failed to gain a foothold.

BACTERIAL DISEASE OF CABBAGE BUTTERFLIES.

On Aug. 21 several dead caterpillars of our common cabbage-butterfly (*Pieris protodice*) were found clinging or rather cemented, to the leaf of the rape-plant on which they had fed. The appearance presented by these caterpillars was quite different from that of the ordinary healthy ones. The skin was brown and shrunken, and the whole body greatly flattened, clinging closely to the leaf. Around the body of one was an incrustation composed of dried body-fluids full of bacteria. This helped to cement the decomposing body to the leaf. On tearing open the body and examining some of its fluid-contents, it was found to be teeming with bacteria of several kinds.

An experiment was made to determine the practicability of spreading the disease by contact of healthy worms with the body-juices of dead and diseased caterpillars. Thirteen healthy cabbage-worms were procured, and their bodies were moistened with the macerated bodies of two diseased larvæ, chiefly along the breathing pores and on the mouth. They were then placed in a cage with rape. On Aug. 23 seven of the larvæ were dead, and of the others two had pupated and four were unchanged and alive, although not bright in color. On Aug. 25 three of the four were dead with the disease and one had pupated, making ten killed and three pupated in four days. The caterpillars attacked by the disease first become inactive and show a general lack of vitality. The color looses its freshness and becomes dull, followed by a reddish and then by a brown shade, which is finally succeeded by a deep reddish or brownish black. The body during these changes often becomes mottled. The interior of the body gradually breaks down, until by the time its skin becomes brown it is a mere bag or skin full of putrid matter. The body now flattens, as the caterpillar dies clinging closely to the leaf, until a rupture occurs, usually caused by its own weight, when the fluid-contents pour out and form a dark brown or black stain across the leaf over which they flow. During these changes the body of the caterpillar often clings with its fore-legs, allowing the rest of the body to hang limp. The illustration (Fig. 18, Plate 1) shows these caterpillars two days after inoculation still clinging to the leaf on which they fed.

On Aug. 25 a dilution-culture was made from the body-juices and intestines. Six species of bacteria were found, and as it was impossible to say which of the six produced the disease, the following experiment was made: eight cages were prepared with food, and five apparently healthy caterpillars placed in each. The caterpillars in each of the six cages were infected with one of the species of bacteria obtained from the dilution-culture, in the following manner: an agar-culture was stirred up with a sterilized needle and a little distilled water was added; the caterpillars were then each dropped into the tube and shaken; they were then placed on the food in the cage. One cage was left uninfected as a check, and the caterpillars in the remaining cages were infected with material obtained from a dead caterpillar. After four days the greatest number of deaths were seen to have occurred among those caterpillars directly infected from the dead ones, and next to these were those in a cage infected with a species of bacteria which grew in plate-cultures in a large, lobulated form. The caterpillars in the other cages died as well, and showed the disease, (it now being impossible to obtain perfectly healthy material here at the station), but not quite as promptly or in as great numbers. The species which produced the lobulated colonies seemed, therefore, the one which was desired, so on Sep. 3 two more cages were prepared, each containing fifteen caterpillars. The contents of a tube containing a bouillon-culture of the suspected form was poured over the larvæ in one. After three days ten were dead in the infected cage, and in the check only five. In four more days all were dead in both cages.

The disease had by this time become so widely distributed that it was impossible to obtain healthy caterpillers on which to experiment. It was thus impossible to say which caterpillar died from infection and which from having been accidentally infected by handling, or before capture.

An attempt was made on September 11, to render the destruction by the disease more complete by more evenly and thoroughly spreading the germs in the field. For this purpose about one hundred diseased caterpillars were collected and shaken in a jar of water. This was mixed with about three gallons of tepid water and allowed to stand for one day. It was then applied by means of a knapsack sprayer to a field of cabbage in which were many apparently healthy and a few diseased caterpillars; in three days scarcely a live caterpillar was to be seen. All were dead and clinging to the leaves.

Many diseased worms were collected and dried on a bit of the leaf to which they were fastened. It is to be hoped that from these dried caterpillars, or from the pure cultures of the bacteria, the disease may be started again the next season.

DISEASE OF TENT-CATERPILLARS.

A disease very similar to that attacking the caterpillars of the cabbage-butterfly was found to attack the tent-caterpillars. A single specimen was found at Taylor's Falls on June 15. The loose flaccid skin with the body-juices fast becoming putrid hung to a plant. The color of the larva was practically normal, but the form was merely that of a bag.

A dilution-culture yielded two species of bacteria in abundance. Pure cultures were made from these, from which it may be possible to start the disease during the coming season. Unfortunately by the time that the cultures were obtained, the caterpillars had all disappeared, rendering any immediate attempt to infect them impossible. This disease occurs with great regularity in Minnesota, most usually becoming powerful enough to kill the great majority of these very destructive caterpillars during the third season in which they are numerous in any particular place. During the first season of the presence of these caterpillars but little damage is caused beyond the defoliation of their most favorite food, the linden; in the second season they are very numerous, and sometimes defoliate every plant over a large area; in the third season immense numbers hatch, but before they reach their full size the disease attacks them, and it is sometimes difficult to find healthy caterpillars. Even if some succeed in forming their beautiful golden-yellow, silken cocoons, it is found that they die inside of them and before assuming the pupal stage or soon afterwards. It would be very important to introduce this disease during the first season and thus save great losses and annoyances.

MIGRATORY LOCUSTS OR GRASSHOPPERS.

Among the worst pests known are insects of this kind, and it is not strange that grasshopper-plagues are never forgotten by persons that have experienced them. The losses caused to farmers and gardeners, in fact to all classes of people, have been so enormous in the past, that a repetition of such a plague is greatly to be dreaded. In the past the Colorado or "Hateful Locust" (*Melanoplus spretus* Uhl.), was the only species that invaded our state in such immense armies that the ground was covered with them, and that every green blade and leaf disappeared almost in a night, Since 1885 but few specimens of this locust have found their way into our state; those that found a lodgment in Otter Tail county, after causing much damage, were destroyed in 1889 by a system of thoroughly plowing all soil in which eggs had been deposited. Once more, in 1890, specimens of this insect reached our state, and located with two other migratory species in the central parts of the Red River Valley, extending from Crookston to north of Hallock. This swarm, which passed over Crookston on Aug. 14th, flying in a south-easterly direction, was partly destroyed in the same season by dropping in the upper Rice Lake, in the White Earth Indian Reservation. But a large number of the heavy females, filled with eggs, had dropped to the ground, and had deposited eggs in the more sandy portions of Polk, Marshall, and Kittson counties. Here the young locusts hatched in large numbers, but were killed by plowing and the use of "hopperdozers" in the following spring, so that none of the Colorado species remained, and only a few of the lesser migratory locust and the pellucid locust, which came with the former. There can be but little doubt that a few specimens of the latter two species, instead of being killed in the lakes, continued their flight, and lodged near Duluth, where they deposited eggs. In consequence of this a few specimens were found in Duluth in the early summer of 1891, and some of them were mailed to the writer from that place. In 1892 they became very numerous and caused some damage to the lawns and gardens. In the same year a parasite, the Tachina fly, Fig. 19, became very numerous in the infested region, and killed the great majority of the intruders. Yet enough remained to deposit a large number of eggs, which wintered well, and produced a correspondingly large army of destructive locusts in 1893. Towards the end of June the writer investigated the actual conditions existing in and near Duluth, and discovered a very peculiar state of affairs. As is well known grasshoppers do not like to rest upon moist ground, but always crawl away from it by climbing upon higher plants, or fences and outhouses if such are near. While in Duluth it rained, and consequently the grasshoppers tried to escape to more elevated positions than the wet soil. They did so by crawling upon the walls of houses, which were crowded with them. Strange to say nearly all the grasshoppers found in the lower part of the city were members of the pellucid species, while the lesser migratory species could only be found near or upon the top of the hills. To express this fact in numbers 1000 grasshoppers were caught with a net on the front of a house on Second street, and were carefully inspected; all were pellucid locusts (*Camnula pellucida* Scud.). Another thousand were captured in the same way on Fourth street: 880 were pellucid locusts, 96 were the lesser migratory locusts (*Melanoplus atlanis* Ril.), and 24 were the common red-legged locust (*Melanoplus femur-rubrum* De G.) Still another thousand were captured at the base of a large building, the Pavilion, which is located on the top of the hill overlooking the wonderful scenery of Duluth and its harbor. Here it was found that 972 specimens belonged to the lesser migratory species, 3 to the pellucid, and 25 to the red-legged kind. This peculiar distribution of the two migratory species was also seen elsewhere; wherever the soil was thoroughly dry and well drained, the lesser migratory species was found in largest numbers, but where the soil was moist or near water or swampy places, the pellucid species was most numerous. In 1894 the locusts became very numerous and caused considerable damage in and near Duluth, by almost denuding the lawns and gardens near that city. They were in the beginning of the season most numerous in the more elevated places and upon the slopes of

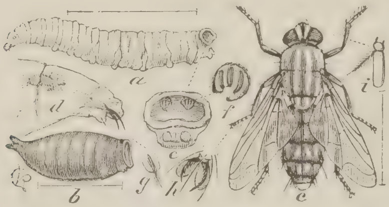

FIG. 19.--*Sarcophaga carnaria* var --*a*, larva; *b*, pupa; *c*, fly. the hair lines showing average natural length. (After Riley.)

the hills, but as soon as the food became scarce in these localities the grasshoppers invaded the lower portions of the city and vicinity and destroyed almost every green thing in fields and gardens. As they reached their adult stage numerous swarms left the infested region in search of more suitable feeding-grounds, and became thus established in many places south and south-east of Duluth. No doubt other swarms had migrated as early as 1893, and had found new homes near Pine City, Rush City, Taylor's Falls, and elsewhere. As has already

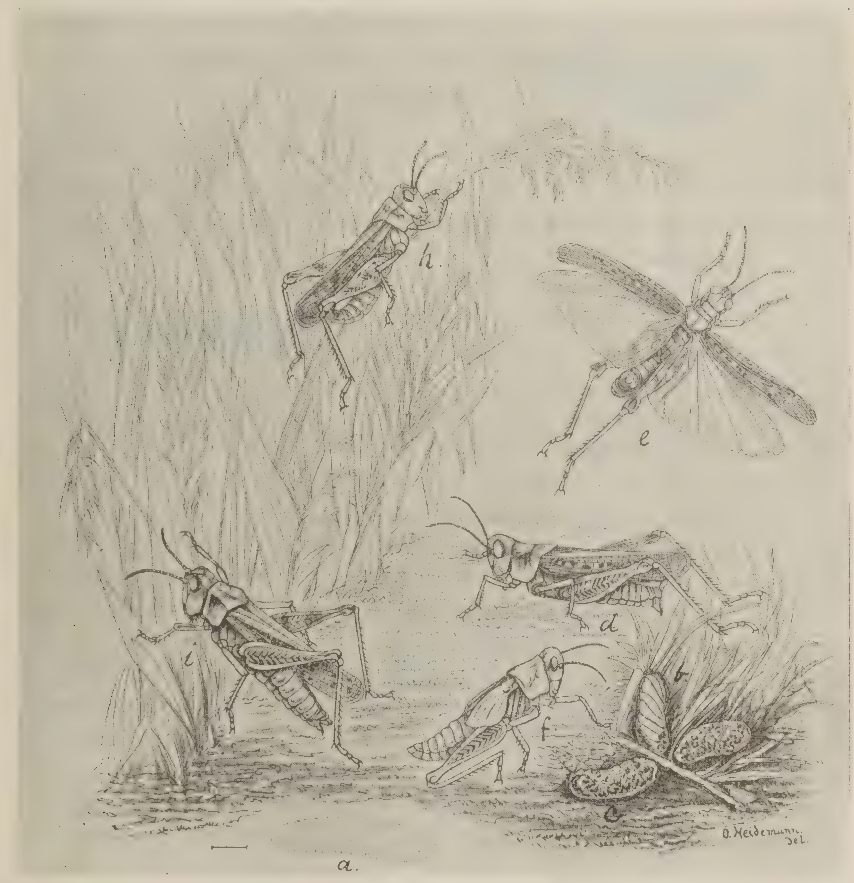

FIG. 20.—*a*, single egg of Pellucid Locust; *b*, egg-mass opened to show eggs inside; *c*, egg-mass; *i*, female; *h*, male. Lesser Migratory Locust; *d*, female; *e*, male; *f*, pupa Natural size. Original.

been stated, the habits of the two migratory species now found in Minnesota vary to some extent, and it is best to describe them in detail.

THE LESSER MIGRATORY LOCUST.

(*Melanoplus atlanis* Riley.)

This locust, of which an illustration is given in Fig. 20, *d*, *e* and *f*, resembles very closely the Rocky Mountain species, Fig. 21, but is a little smaller. Of course there are other distinguishing characters not necessary to enlarge upon at this time. Like the former species it has wings much longer than the body, and is thus enabled to fly long distances. The longer wings, besides other characters, distinguishes it from our common red-legged locust, which is illustrated in Fig. 22. The lesser migratory locust is essentially an eastern species, and is found in larger or smaller numbers from the northern part of Florida to the extreme north of eastern United States. Like the "Hateful" western locust it is single brooded in Minnesota, but has the tendency to become double-brooded, a property in our favor, as all the young that are hatched during a warm autumn are doomed to die. This species matures more rapidly than the pellucid and the Rocky-mountain species, hatching early in May and becoming winged early in July. This depends to a large extent upon the climatic conditions prevailing in that year. Eggs are deposited soon afterward, and oviposition continues for several months, though specimens of the adult insects become very scarce early in September, and those found show their old age by the frayed out wings. The life-history of this insect is almost identical with that of the western or Rocky-mountain species. It seems to be a geographical variety of the same, which has established a home in the eastern mountains, where it always breeds, and on account of which it is frequently called the "White Mountain Locust." It is a very

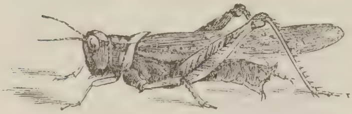
FIG. 21.—Rocky Mountain Locust. Natural size. After Riley.

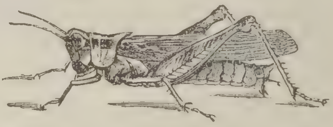
FIG. 22.—Common Red-Legged Locust. Natural size. After Riley.

destructive species and the great losses to all kinds of crops sustained in different regions of New England from locusts are all owing to this insect.

As it has been found that the best method of combating this insect consists in plowing the ground after eggs have been laid, it is necessary to study these in detail, and I quote from bulletins 8 and 17 published by the State Experiment Station.

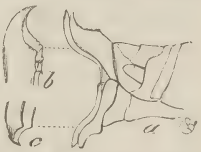

FIG. 23.--Rocky-Mountain Locust.-Anal characters of female, *a*. showing horny valves. *b*, and c. (After Riley.)

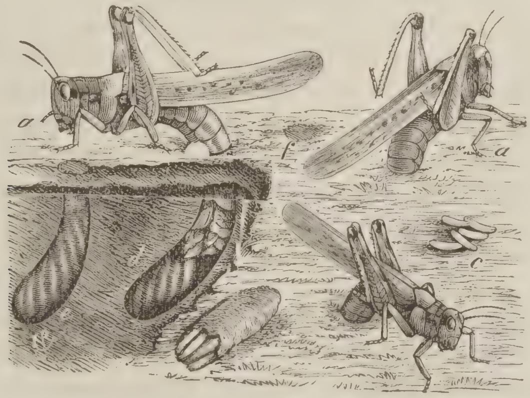

FIG. 24.--Rocky-Mountain Locust, in the act of laying eggs. (After Riley.)

How the eggs are laid. In my report of 1888, considerable stress was laid upon the manner and location in which eggs are laid by the Rocky-mountain locust and allied species As the remedy applied this year depends almost entirely upon this I deem it important to repeat and enlarge upon what was written at that time. The following figures will illustrate this point better than words. The holes for the reception of the eggs are made by means of two pairs of horny valves at the tip of the abdomen of the female (Fig. 23, b and c). These open and shut rapidly, and are well adapted to execute this function. The female pressing the tip of her abomen forcibly against the soil, rapidly opens and shuts these hard and pointed valves, and soon pushes them into the ground, thus drilling a hole. Fig. 24 illustrates this action, and the various positions assumed by the female are plainly indicated. In a short time nearly the entire and greatly extended abdomen is inserted in a little curved and more or less oblique cavity. The legs are hoisted above the back during the operation of drilling this hole, which requires more or less time, depending entirely upon the condition and character of the soil. As soon as the hole is finished, it is filled with a frothy and mucous material. Professor Riley, in describing the method of laying eggs, writes: "By repeatedly extracting and studying specimens in every stage of oviposition, we have been able to acertain the exact method by which the egg-mass is formed. If we could manage to watch a female from the time the bottom of her hole is moistened by the sebific fluid, we should see the valves all brought together, when an egg would pass down the oviduct along the ventral side, and, guided by a little finger-like style pass in between the horny valves, and issue at their tips amid the mucous fluid already spoken of. Then follows a period of convulsions during which more mucous material is elaborated, until the whole end of the body is bathed in it, when another egg passes down and is placed in position. These alternate processes continue until the full complement of eggs are in place, the number ranging from twenty to thirty-five, but averaging about twenty-eight. The mucous matter binds all the eggs in a mass, and when the last is laid, the mother devotes some time to filling up the somewhat narrower neck of the burrow with a compact and cellulose mass of the same material, which, though light and easily penetrated, is more or less impervious to water, and forms a very excellent protection. When fresh the mass is soft and moist, but it soon acquires a firm consistency.

"To the casual observer, the eggs of our locust appear to be thrust indiscriminately into the hole made for their reception. A more careful study of the egg-mass, or egg-pod, will show, however, that the female took great pains to arrange them, not only so as to economize as much space as possible, consistent with the form of each egg, but so as to best facilitate the escape of the young locust; for if, from whatever cause, the upper eggs should fail to hatch, or should hatch later than the lower ones, the former would offer an impediment to the exit of the young in their endeavor to escape from these last, were there no provision against such a possibility. The eggs are, indeed, most carefully placed side by side in four rows, each row containing seven. They oblique a little cross-wise of the cylinder

(Fig. 25, *a*). The posterior or narrow end, which issues first from the oviduct, is thickened, and generally shows two pale rings around the darker tip (Fig. 25, *b*). This is pushed close against the bottom of the burrow, which, being cylindrical, does not permit the outer or two side rows to be pushed quite as far down as the two inner rows, and for the very same reason the upper or head ends of the outer rows are necessarily bent to the same extent over the inner rows, the eggs when laid being somewhat soft and plastic. There is consequently an irregular channel along the top of the mass (Fig. 25, *c.*) which is filled only with the same frothy matter that surrounds each egg, which matter occupies all the other space in the burrow not occupied by the eggs. The whole plan is seen at once by a reference to the accompanying figure, which represents, enlarged, a side view of the mass within the burrow (*a*), and a bottom (*b*) and top (*c*) view of the same, with the earth which adheres to it removed."

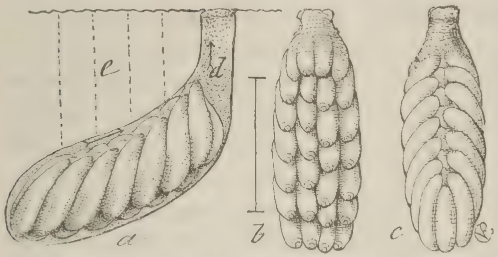

Fig. 25.—Egg-mass of Rocky-Mountain Locust—*a*, from the side, within burrow; *b*, from beneath; *c*, from above; enlarged. (After Riley.)

"Each female of the Rocky-mountain locust lays on an average about three egg masses; this is done at intervals of two weeks, so that the egg-laying season extends from six to eight weeks."

"The egg is surrounded by a shell consisting of two layers, of which the outer one is thin, semi-opaque, thus producing the creamy-yellow color; highly magnified it appears (Fig 26, *a*) densely and minutely pitted or rather netted with minute and hexagonal ridges (Fig. 26, *b.*) The inner and thicker layer is deep yellow, smooth and translucent, so that the form of the embryon can be plainly seen when maturing inside. The outer layer is quite brittle, but the inner one very tough, requiring a strong pressure to rupture it. As the embryon within matures (Fig. 26, *c*), the egg-shell becomes weakened, and the egg plump and somewhat more transparent. By the muscular efforts of the enclosed insect, but chiefly by the thorns arming the hind tibiæ, Fig. 26, *e*, the shell is eventually broken, and the young locust pushes its way through the neck of the burrow towards the light.

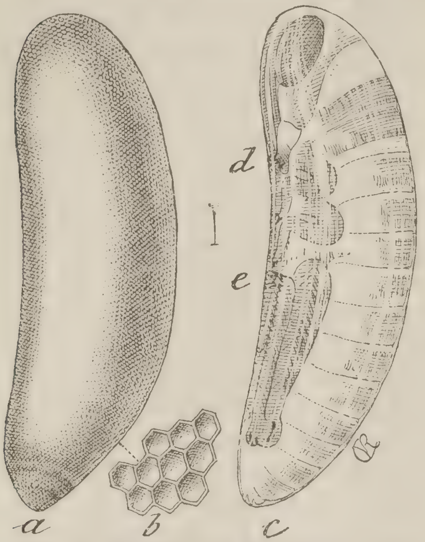

FIG. 26.—Egg of Rocky-Mountain Locust—*a*, showing sculpture of outer shell; *b*, the same very highly magnified; *c*, the embryo, just before hatching. (After Riley.)

"Nearly all the eggs in a pod hatch at the same time, and the young escape through the small hole left for this purpose. When the young insects reach the surface they are quite weak, and still surrounded by a very delicate film, which has to be first removed before the young locust can jump about. By contracting and expanding muscular movements this enveloping film splits along the middle of the back, near the head, and is gradually pushed backwards, remaining as a white crumpled pellet behind. At first pale and colorless, the young locust assumes its dark color in the course of an hour.

"From this account of the hatching process, we can readily understand why the female in ovipositing prefers compact or hard soil to that which is loose. The harder and less yielding the walls of the burrow, the easier will the young locust crowd its way out.

"Though the covering which envelopes the little animal when first it issues from the egg is quite delicate, it nevertheless, in the struggles of birth, undoubtedly affords much protection, and it is an interesting fact that while, as we have seen, it is shed within a few minutes of the time when the animal reaches the free air, it is seldom shed, if, from one cause or another, there is a failure to escape from the soil, even though the young locust may be struggling for days to effect an escape.

"While yet enveloped in this pellicle, the animal possesses great forcing and pushing power, and if the soil be not too compact, will frequently force a direct passage through the same to the surface, as indicated at the dotted lines (Fig. 25, *e*). But if the soil is at all compressed it can make little or no headway, except through the appropriate channel (Fig. 25, *d*). While crowding its way out, the antennæ and four front legs are held in much the same position as within the egg, the hind legs being generally stretched. But the members bend in every conceivable way and where several are endeavoring to work through any particular passage, the amount of squeezing and crowding they will endure is something remarkable. Yet if by chance the protecting pellicle is worked off before issuing from the ground, the animal looses all power of further forcing its way out. The instinctive tendency to push upwards is also remarkable. In glass tubes, in which I had the eggs hatching in order to watch the young, these last would always turn their heads and push toward the bottom whenever the tubes were turned mouth downwards; while in tin boxes, where the eggs were placed at different depths in the ground, the young never descended, even when they were unable to ascend on account of the compactness of the soil above."

"The above minute account of the manner in which eggs are laid, and how the young are enabled to reach the surface, plainly indicates one good method by which the hatching of the eggs may either be prevented entirely, or by which the young may be prevented from reaching the surface. By plowing the fields containing eggs of the Rocky-mountain locust, we perform two operations: we first of all remove the eggs from near the surface and cover them with five or six inches of soil; secondly, we invert the position of the hole containing the egg-mass, so that instead of its mouth pointing upwards, it now points downwards. At all events, the young insects are prevented from reaching the surface, if this becomes compact by rain and snow. Consequently if we plow during autumn or soon after the eggs are laid, we are safe; although if we plow in the spring with a normal amount of rain, we also effectually prevent their hatching and escape. Plowing has this additional advantage: the egg-masses in most cases are thoroughly broken up, the individual eggs become surrounded by earth and moisture, and being no longer protected by the water-proof coat of dried mucous matter, they soon rot and perish."

"To repeat again: if we desire to get rid of the migratory species of locusts now infesting several counties in the state it is absolutely necessary to plow every inch of the cultivated ground throughout the invaded region in which eggs have been laid."

THE PELLUCID LOCUST.

(*Camnula pellucida* Scudd.)

This locust belongs to a different sub-family of grasshoppers than the lesser migratory locust; in fact it is related to the North African and Asiatic species so well described in holy scripture. It is much more robust than either of the other two migratory species. Fig. 27 shows this species with wings expanded, and fig. 20, *i* and *h*, shows both the male and female insect, as well as the egg and egg-masses *a*, *b* and *c*. The pellucid locust has a rather wide distribution, occurring in California, Utah, Wyoming, Colorado and other western states. It occurred in immense swarms in California during the years 1877, 1878, and 1879, leaving devastation in its wake. The flight of these pellucid locusts is quite different from that of the two other migratory species, as they do not raise to a very high elevation, nor do they fly so continuously. By a careful comparison of the illustrations it will be seen that this species is quite different from the others illustrated, nor does it resemble any of our native species.

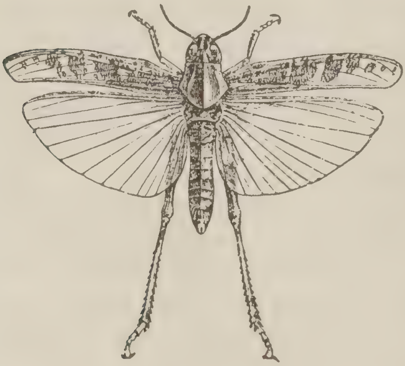

Fig. 27.—The Pellucid Locust. After Riley.

The females of the pellucid locusts commence to deposit their eggs about the end of July, usually at least fourteen days later than the other migratory locusts. Their method of doing so is entirely different. As a general rule they select for this purpose pasture land, road sides, or, by preference, clearings from which the stumps have not yet been removed, although the land has already been used for crops. In such places large numbers of eggs are deposited in the sod. Usually they are placed right upon the surface of the soil, where they are protected by the grass and by the rubbish found in such situations (Fig. 28, Plate 16). Occasionally the eggs are deposited just beneath the surface, but only when the ground is sufficiently loose to enable the insects to do so. The eggs are about 4 mm. in length, and 1 mm. in diameter; they are slightly curved and rounded at the ends (Fig. 20, *a*). They are deposited in layers, each with three or four eggs, which overlap and appear somewhat irregular, as is shown in Fig. 20, *b*. These diagonally overlapping layers are built up until an elongated cylindrical mass from 10 to 15 mm. in length is formed. This whole mass of eggs is protected by a waterproof covering composed of bits of earth cemented together with the frothy material produced by the mother insect at the time the eggs are deposited and arranged by her. One end of this protective layer of waterproof material is very thin, almost or entirely open, thus affording the young and weak locust an easy means of egress. Each cylindrical capsule contains about twenty eggs. In many places, in which the grasshoppers have been very numerous, in a square inch of sod were found as many as six egg masses, which means 17,000 eggs to the square foot, enough to make crops in their vicinity a very problematical affair for 1896.

As has been stated before, the only method to reduce and destroy these injurious insects, that promises success, is the plowing of all the land in which eggs have been deposited. And in this case, as in so many others, where measures are directed against destructive insects, concerted action is all important. If one farmer does this work in a careful manner, and his neighbor refuses, perhaps, to plow up a piece of meadow land filled with eggs, all the work of the farmer will be more or less performed in vain, as the careless farmer can breed upon his land enough grasshoppers to destroy the crops of many of the surrounding farms. We still lack laws that in a case like this can force the negligent farmer to do his part of the work to get rid of such dangerous intruders, and unless such laws are made and enforced, no uniformly good results can be expected from any methods that might be applied to route the enemy.

GRASSHOPPERS NEAR TAYLOR'S FALLS AND ELSEWHERE.

Early in June a number of letters were received from Mr. Luke Stannard and others, of Taylor's Falls, Minn., in which it was stated that great damage was being done by grasshoppers, and that the farmers in that region feared losing their entire crops. In the absence of the Governor the entomologist consulted with Hon. Tams Bixby, who represented the Governor, and with Hon. Rob't. Dunn, the State Auditor. It was agreed that, if necessary, steps should be taken to assist the farmers against this insect, and that all possible means should be employed to prevent this pest from spreading over a larger territory than already occupied. The entomologist called at Mr. Luke Stannard's, but found him away from home. Mr. Anderson, the well known representative of the district in which the grasshoppers were found, very kindly assisted the entomologist to make a thorough examination. This gentleman deserves very great credit for the pains he took all through the work of fighting the grasshoppers to assist the farmers in the infested region; without his unselfish and intelligent co-operation not much work could have been accomplished.

It was found that in a space of from thirty-six to forty square miles the ground was more or less badly infested with grasshoppers; in some places the ground was perfectly black with these insects, while in others near by but few could be detected. This showed that the young locusts were still in the vicinity of the places in which they were born. The damage done at this time was but slight, as, apparently only pasture land had as yet suffered, but as the young hoppers were moving towards timothy and grain-fields, no time was to be lost in applying remedies. After another consultation with the gentleman mentioned above, both of whom felt deep interest in the matter, it was concluded to utilize "hopperdozers" and kerosene oil, as no other remedies could well be applied at that late period. Consequently 230 "hopperdozers" were made and operated near Taylor's Falls, Rush City, and Duluth, which required in all 95 barrels of kerosene oil. Besides this, smaller amounts of kerosene oil were bought in the beginning of the work wherever it could be obtained, in all about ten barrels; in some few cases the farmers also furnished some oil, although this was exceptional, as but little oil is found in the possession of farmers during the summer.

The "hopperdozers" used at Taylor's Falls, Rush City, Duluth and elsewhere, were made as follows: a sheet of ordinary sheet iron, such as is used for making stove-pipes, was turned up one and one-half inches around the edges and riveted at the corners. This made a shallow pan about eight feet long, two feet broad and one and one-half inches deep. To the bottom of this were riveted the six small strips which could be fastened to the three runners on which the pan rested. To the rear side of the pan was screwed a light wooden frame, as long as the pan and one and one-half feet high. Over this frame a piece of canvas was stretched. This frame served the important office of throwing back all those grasshoppers that otherwise would jump clean over the pan, and throw them into the oil.

The runners on which the pan stood were usually made from saplings or small pieces of board having an upward curve in front to prevent them from catching in the ground. The front ends of the runners were all fastened by screws to a cross-piece which was, in turn, drawn by two ropes, one at each end. These ropes were joined in front and fastened to a single-tree, (Fig. 29, Plate 3). Sometimes two "hopperdozers" were fastened to a long pole by means of short ropes; this was very easily drawn by one horse. Just in front of the pan was fastened a piece of rope which swept the ground a few inches in advance, and served to stir up the hoppers and make them jump into the pans. In the pan was laid a piece of cloth, which was first thoroughly saturated with water. About a pint of kerosene was then thrown in and the upright sheet or sail of canvas moistened with oil. The machine was then drawn over the pasture or wherever the hoppers were thickest. In a short time it was usually seen to be partially filled with dead and dying insects.

The slightest touch of kerosene, either from the pan or from the canvas sheet, means death to the hopper, for the oil spreads over its body in the same way that a single drop will spread over a large surface of water. It seems to produce a paralysis, which is first shown by the stiffening of the legs. A very large proportion of the hoppers that came in contact with the oil in the pan immediately jumped out again, but they invariably died in the course of a few seconds or minutes. Fig. 30, Plate 4, shows a hopperdozer in operation in a hay-field. A narrow strip was cut around the margin of the field and the hopperdozer drawn around in this strip, with great success. Fig. 29. Plate 3, shows two fastened together and drawn side by side. Figs. 31 and 32 show two other hopperdozers more in detail so as to enable anybody, even with but little ingenuity, to make them. The nature of the ground in the infested region did not, in many places, admit of using more than one hopperdozer at a time.

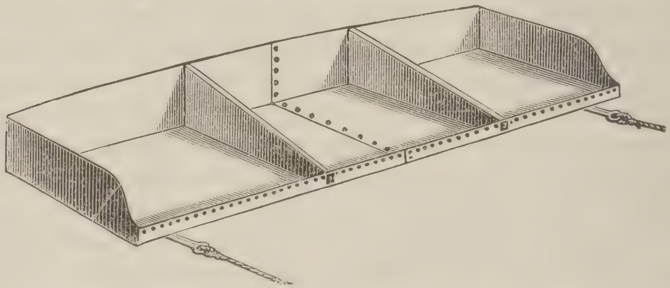

Fig. 31.—Large Hopperdozer, with partitions. After Riley.

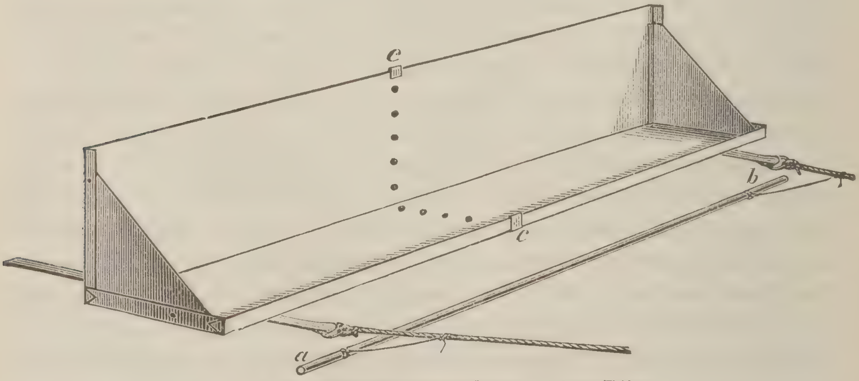

Fig. 32.—Smaller Hopperdozer. After Riley.

The farmers in the infested region watched with great interest the operations with the few hopperdozers first made and used upon the farm of Mr. Stannard. Many farmers from far and near were present and when they saw the possibilities of these simple machines they were not slow to realize that by faithful work they could largely protect their very promising crops. Generally speaking the farmers showed a very commendable spirit to fight their enemy, and they went to work with a will. Yet notwithstanding all this the grasshoppers would have done a vast amount of damage if the climatic conditions had not been very favorable to the farmer. At the time when grasshoppers are most voracious, and when they usually move about in large armies from field to field, a great number of light rains fell at frequent intervals, assisting the plants most wonderfully in their growth, while greatly dampening the ardor of such warmth-loving insects as the grasshoppers, which, as mentioned before, are also not fond of moisture. These rains helped the growth of the plants and retarded that of the grasshoppers. Later when these very seasonable rains ceased to fall, the plants of rye, oats, and wheat stood so close and were so rank that the ground was most thoroughly shaded, and being shaded retained the moisture for a long time. This condition of the grain-fields was not at all to the liking of the grasshoppers. They wandered about the edges of such fields, but did not enter, except in cases where the ground was very poor or the stand of grain irregular; here they caused some damage, chiefly to the oats. As a general rule, however, the grain escaped unhurt, and only pastures, meadows, and some old timothy-fields suffered greatly. This state of affairs assisted farmers greatly in fighting the enemy, as they did not need to use the machines in the grain-fields themselves but only along the borders.

Immense numbers of grasshoppers were killed before they caused much damage, and the state at large ought to be thankful to these farmers, since without their labors the locusts might have spread over the larger part of the state, instead of being confined to a small portion of it. How many grasshoppers are killed by a hopperdozer is difficult to say, as nine out of ten that jump into it jump out again, only to die soon after in the field. But if only five or six bushels of the still small grasshoppers are scraped off the "dozer" during a day's labor, this would mean fifty or sixty bushels killed by a single machine. This is by no means an exaggerated estimate, but if only ten per cent of this amount were killed, it would well pay for the work. Kerosene-oil has this additional advantage that it leaves a strong odor behind, which is very apt to spoil the appetite of the grasshoppers which escape destruction, and which will drive them away to less highly-scented pastures. As this oil kills plants as well, proper care in handling the hopperdozers should be observed, otherwise much injury can be caused by careless work.

Hopperdozers, though very good machines upon level ground, free from trees and stumps, can not be used in all places. Some farmers living upon a newly opened farm, upon which many stumps were standing, managed their machines in a very peculiar and ingenious manner. Instead of moving the hopperdozer they drove the hoppers themselves into the pan, which in this case was used in the same way as a corral is used to capture cattle or horses. Though much slower these intelligent farmers still succeeded in killing the greater number of their enemies and saved their crops.

In places where the hopperdozers can not be used on account of the rough, unequal or too sloping condition of the ground, and where cattle and chickens can be kept away, there is no better way of destroying large numbers of the locusts than by the use of poisoned baits made of bran-mash. This is made by thoroughly mixing Paris green or London purple with dry rye or wheat bran, about one and one-half to two pounds of the poison to twenty-five pounds of bran is a good proportion; to this is added enough water to form a mash thick enough to be formed into balls without falling apart when laid upon the ground. Frequently cheap molasses is added to keep the mash from becoming too dry.

But, after all, no matter how useful hopperdozers may be against grasshoppers and other insects, they are only a makeshift to be employed when other remedies can not be employed. In many places they cannot be used at all; for instance, not upon the hillsides of Duluth, upon which immense numbers of grasshoppers have found a home. Here other machines might be used, which capture the grasshoppers in bags, and in which the insects are ground up by rollers. Poison could also be applied where cattle and chickens can be kept away. The true remedy consists in plowing, as has been described before, and wherever grasshoppers are numerous this method has to be resorted to. Of course it would be best to plow the soil containing eggs during the autumn, as by doing so the surface of the plowed ground becomes thoroughly compacted by rain and snow. Plowing in spring, if well done and as early as possible, will also be successful, though in some cases a few grasshoppers may succeed in reaching the surface.

In regard to the Rocky Mountain locust, it is possible that a small swarm of this destructive species has again settled in our state. At least it was stated in some newspapers published in the Red River Valley, that a swarm had been observed sometime during the middle of August, flying in a south-easterly direction over Polk county. Inquiries failed to determine positively whether they had settled or not; if they have they will be found south of Crookston, and farmers located in that region should watch carefully, and give timely warning of their presence, so that steps can be taken to prevent their increase.

PARASITIC ENEMIES OF MIGRATORY LOCUSTS.

The Red Mite—(*Trombidium locustarum* Ril.)—Early in the spring of 1895 the full grown red mites or locust mites illustrated in figs. 32½ and 33, were found running about almost everywhere in fields and gardens. These friendly mites, of a vivid scarlet color, and with the peculiar gloss of silk, are well known to children, who are in the habit of calling them the "lucky spiders," very likely from the German "Glueckspinnen," because finding them in the early spring is claimed to be a certain promise of a lucky day. And no wonder, because they are only found running about on warm and dry spring days, when all nature is reviving from a long winter's rest, when the bare and

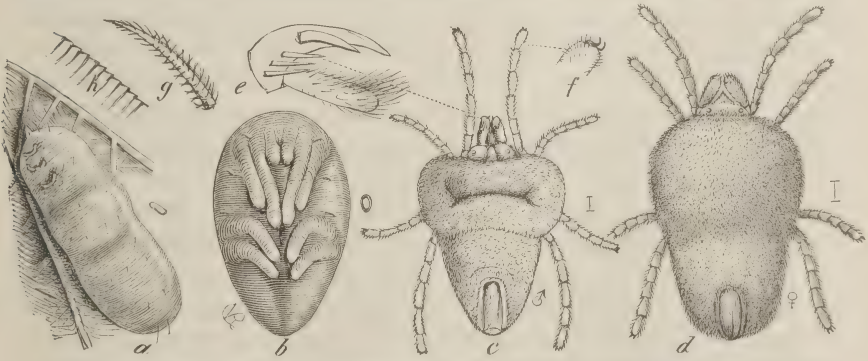

Fig. 32½—*Trombidium locustarum*.—*a*, mature larva when about to leave the wing of a locust; *b*, pupa; *c*, male adult when just from the pupa; *d*, female—the natural sizes indicated to the right; *e*. pupal claw and thumb; *f*. pedal claws; *g*, one of the barbed hairs; *h*. the striations on the larval skin. (After Riley).

cold ground becomes clothed in delicate green colors, and when the first flowers gladden the eyes. The illustration (Fig. 32½), shows the great difference that exists between the sexes. During the spring the females deposit from three hundred to four hundred very small, globular, orange-colored eggs, which are usually hidden in the soil at a depth of one to two inches; this is shown in fig. 33, *a*, as well as an individual egg, *c*. These eggs soon give forth small orange-colored, six-legged and very active mites, fig. 33, *b*, whose aim in life seems to be to find living food to which they fasten themselves. If they succeed in finding a locust, they fasten themselves very securely to its wings, or in case of a pupa to its wing-pads, and almost invariably to their under side. Here they use their mouth-parts so diligently, that their bodies soon swell with the life-blood of the attacked host; their former long legs become shorter and shorter in proportion, and are soon almost invisible (Fig. 32½ *a*). In this condition they can, of course, no longer move about, and they look very much like a minute drop of blood, or as an egg, and are frequently mistaken for such. We can well imagine that a locust thus infested by one or more of such rapid growing mites, must soon become disabled, or at least greatly weakened. To such locusts life is no longer a continuous round of pleasure, and they soon take a gloomy view of it, or refuse to join their festive brethren; they either congregate with similarly affected ones, and are thus found in large numbers upon fences, etc., or they drag about their enfeebled bodies separated

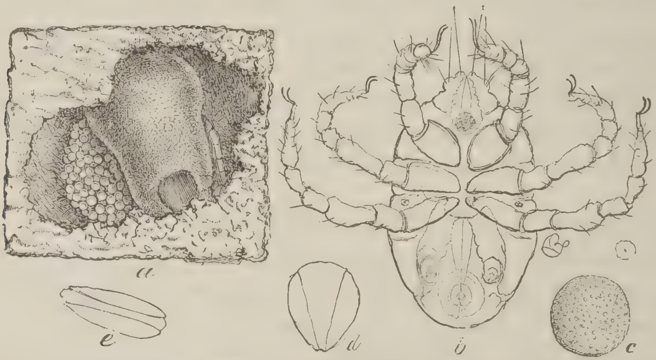

Fig. 33—*Trombidium locustarum*.—*a*, female with her batch of eggs (after Emerton); *b*, newly hatched larva, natural size indicated by the dot within the circle; *c*, egg; *d*, *e*, vacated egg shells. (After Riley).

from their relatives. When these mites fastened to locusts become fully grown they drop to the ground, and hide for several weeks without taking any food. Gradually the pupal state is assumed, without going through a molt, as would be the case if mites were true insects. Inside this pupa, shown in fig. 32½, *b*, the mature mite is formed. Breaking through the retaining pupal skin it appears as an eight-legged being, which passes the winter in the ground. But the mite is not idle, excepting when the temperature sinks below the freezing point. It feeds upon all sorts of soft food, and whenever it has access to the eggs of locusts it greedily eats them. In soil containing eggs of locusts large numbers of these mites congregate. They creep into every hole in search of such eggs and thrive upon such rich food.

Last summer many mites of this kind were found fastened to locusts, both of the native and the migratory species. They have doubtless done much good and will do more in 1896. The great advantage of plowing over all other remedies is also seen in regard to these red mites, as the plowing of fields in which eggs of locusts have been deposited will destroy the young locusts hatching from them, but not the mites, which can easily work their way towards the surface. Plowing destroys our enemies but not our friends.

Tachina-flies.—These beneficial flies, already mentioned, are generally of a gray color, and resemble very much large house-flies; they are of great assistance in killing locusts. Large numbers of them were observed last summer, not as often in their winged stage, however, as in their early larval stage inside the body of the locust. Yet many were seen buzzing around the wide-awake locusts, who seemed to know the threatening danger, as they would dodge the flies in the most ridiculous manner. But all dodging and kicking proved in most cases of no avail, as the persevering flies would usually succeed in fastening a white, elongated egg upon the neck of the hopper, or under its wings. The maggots hatching from such eggs eat their way into the body of the victim. Here they devour everything, frequently leaving, however, the vital organs untouched, as being, very likely, less tender than the fatty parts stored up for the formation of future organs. If fully grown the maggots force their way through the skin of their host and drop to the ground. Here they burrow in the earth, and, contracting into brown barrel-shaped puparia, they rest for awhile.

Inside this puparium, composed of the old larval skin, the true pupa is formed, and later the winged fly, which breaks through the surrounding skins and crawls towards the light of day. In a very short time it is able to use its wings, and is ready to enjoy life after its own fashion. A locust harboring such a maggot, or several of them, is less active than others, and seems to look upon life as a rather serious affair, in fact to think it a real bore. Fishermen in search of bait catch such languid locusts much more readily than healthy ones, but find, in pulling away their wings or heads, a humane way that disciples of Isaac Walton have, nothing but an almost empty shell, by no means a tempting morsel for a fish. Several species of Tachina-flies infest locusts.

Flesh-fly (*Sarcophaga carnaria* Linn.), a well known scavenger in Europe, Australia and America, is also found as a true parasite in many species of locusts. It, as well as its earlier stages, are illustrated in fig. 19. This illustration will also show the shape, size and general appearance of a true tachina-fly, which is quite similar to it.

Bee-Fly– (*Systœchus oreas*).—During the autumn of 1895 many fields, meadows and pastures were inspected to find eggs of the migratory species of locusts, and invariably the larvæ of this fly were found in large numbers, showing that this friend of the farmer is doing good work. The adult fly is illus

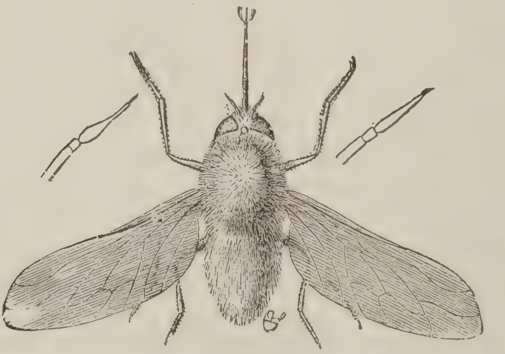

Fig. 34.—*Systœchus oreas.*—Female fly. (After Riley.)

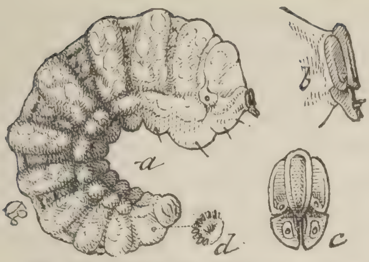

Fig. 35.—*Systœchus oreas.*—*a*, larva; *b*, head from side; c, head from front; *d*, preanal spiracle. (After Riley.)

trated in fig. 34, the larva in fig. 35. The beautiful fly was frequently seen towards the middle of July; they were then employed in sipping honey with their very long proboscis from the various species of composite flowers. This proboscis can be used for other purposes than sipping nectar, as the writer found out to his sorrow, when he attempted to catch some of them with his hand, and succeeded. Violent pain, a swollen finger, and added knowledge was another result of the catch not bargained for. Early in August these flies were exceedingly numerous, hovering in the air and keeping their wings in such rapid motion that they could not be distinguished, but appeared like a haze surrounding the body of the insects; when disturbed the fly would dart away with wonderful speed, to remain again stationary in the air in another spot. These bee-flies, although possessing a blackish-gray ground color, are so densely covered with pale yellow hairs, that it is entirely hidden; this hair is so long that the outline of the insect is obscured, and they resemble on this account very small bumble-bees.

The eggs and method of oviposition are not known. The larvæ are found among the egg-masses of the locusts; they have a curved body, swollen in front and tapering behind; their color is opaque white with translucent yellowish markings. The small and flattened head (fig. 35, *b* and *c*) is dark brown, with broad, almost triangular jaws. All the larvæ found during August and September, though varying greatly in size, possessed similar forms, and all were almost unable to move. They were most frequently close to the egg pods, which in some cases were found empty. The young maggots must possess a very different form and decidedly different habits than the adult larvæ, otherwise they would be altogether too slow and awkward to find the eggs of locusts. No pupæ were found and all the larvæ kept in breeding-cages have neither moved nor changed into pupæ.

Blister-beetles.—Several species of blister-beetles or Spanish-flies occurred in large numbers throughout the infested region. In fact some of them caused considerable damage to the potatoes, as will be mentioned in the article about potato-beetles. Many of these blister-beetles are known to feed in their early stages upon the eggs of locusts. A very interesting report upon the pecular life-histories of these beetles was published in the "First Annual Report of the United States Entomological Commission." The following species of these beetles were abundant: the ash-gray blister-beetle (*Macrobasis unicolor* Kirby), the margined blister-beetle (*Epicauta cinerea* Forst.), the black blister-beetle (*Epicauta pennsylvanica* De G.), and the red-headed blister-beetle (*Epicauta trichrus* Pall.). All these beetles, frequently best known as being very injurious to potatoes, beans and other cultivated plants, surely have one great redeeming character, in being our best friends by checking an undue increase of noxious species of locusts. Their life-history may be summed up in a few words: they deposit, from July to October, their orange or yellow-colored eggs in irregular masses in loose ground, each female producing from four-hundred to five-hundred eggs. In about ten days these eggs hatch, producing very active, long legged larvæ with large heads and strong jaws, which run about searching everywhere for the eggs of locusts. If an egg-pod has been found, the larva forces its way into it and commences to devour an egg; if two larvæ have found the same prize a mortal combat takes place, lasting until a single larva remains as sole owner of this store of food. As soon as one or two eggs have been consumed the larva throws off its skin, and reappears in a very different shape, being now white, soft, and possessing only small legs. In the course of another week a second molt takes place, disclosing a larva with rudimentary mouth-parts and legs, and of a very clumsy aspect. Soon another molt takes place, but only slight changes are seen in this form of the larva. It soon eats the remaining eggs in the pod, and leaving it, burrows in the soil, where it forms a smooth cavity, within which it rests. Soon it splits its skin again, disclosing now quite rudimentary, tuberculous mouth-parts and legs; the semi-pupa thus formed is rigid and of a deeper yellow color. It hibernates in this condition. In spring the skin is again torn open, and a larva appears looking like that of the second shape, but smaller and whiter; it is quite active, but does not seem to require any food. It changes into a true pupa, and eventually into a winged beetle. Two species of blister-beetles are shown on plate 5, fig. 36.

OTHER ENEMIES OF LOCUSTS.

A large number of carnivorous insects assist us in reducing the number of locusts, either by eating the locusts themselves or their eggs. Such beetles as **ground-beetles** devour a large number of the still young locusts, and if at all numerous, assist the farmer materially. **Soldier-beetles** and **lightning-beetles,** both as adult carnivorous insects and as larvæ, also assist in this good work. **Robber-flies** carry off many of the smaller and frantically kicking hoppers; large and small **digger-wasps** store their nests with paralysed locusts, and even **ants** are said to eat not only the dead locusts but young and healthy ones as well.

Many specimens of the peculiar **hair-snake** were found during August in wet places and along the rivers and creeks. These peculiar worms are well known to be internal parasites of insects, but chiefly of locusts.

Birds are of course not slow in making good use of locusts as food for themselves and their young. Nearly every species of bird, even granivorous kinds, seem to enjoy a dish of fat and tender locusts. Some kinds of birds are especially fond of these insects and devour large numbers of them.

Other animals also eat locusts, and the presence of that odoriferous animal, the **skunk,** was often perceived by the nose, but no especial efforts were made to actually watch the animal eating the insects. **Shrews** were numerous and actively at work eating locusts of all sizes, and even the otherwise destructive **gophers** were found to eat such insects. Of course **toads, snakes** and **turtles** are also fond of this food.

POTATO BEETLES.

THE COLORADO POTATO BEETLE.

(*Doryphora decemlineata*, Say.)

It is hardly necessary to introduce this insect to a Minnesota farmer who has ever grown potatoes. The illustration, which is given with this article, (Fig. 36, Plate 5,) shows the different stages of this insect. Yet notwithstanding the fact that it is so well known but very few farmers know anything about its life-history, as is indicated by the numerous letters received during the year in regard to it.

The history of this beetle, given in a few words, is this: a native of the foot-hills of the Rocky Mountains, where it fed upon a wild species of nightshade (*Solanum rostratum* Dunal), it came in contact with the cultivated potato-plant as soon as the first trans-continental railroad was built. Finding the Irish potato to its taste, and finding it also in great abundance, the insect increased wonderfully in numbers by utilizing the food prepared by man, and soon all the potato-fields in the eastern United States were ravaged by it. At first the new-comer had no enemies and nothing kept it in check; and it was a number of years before parasitic and cannibal insects took hold of it, and before farmers learned to use Paris-green and other arsenical poisons against it. The beetle has now a large number of enemies, both among other insects and among birds and animals.

There are three broods of the potato-beetle in Minnesota, of which the last hibernates in the ground in the form of a beetle. Early in spring the winged beetles become active and fly about in the bright sunshine long before any potatoes have been planted. They can exist at this time with little or no food for a month and longer, and can fly long distances and thus invade new regions. As soon as the first potato-plants appear above ground the beetles are sure of finding them, and they lay eggs upon the under side of the leaves near their tips. The beetles themselves do some damage at this time by eating into the very young and delicate plants. The eggs, of which about six hundred are laid by each female, soon give forth hungry larvæ, which eat small and large holes in the growing leaves. In the course of about four weeks, sometimes five in an unfavorable spring, the larvæ are full grown and descend to the ground and enter the same, forming, at a slight depth, a smooth cavity in which they transform to pupæ, as shown in the illustration. This pupa soon changes to a beetle which, when sufficiently hardened, works its way to the surface, and soon starts a second brood. This brood again undergoes the same changes and soon beetles of a second brood will be found upon the potato vines, where the female deposits the eggs for the third and last generation. The larvæ from this generation enter the ground when full grown, transform to pupæ, and soon after to perfect insects. This perfect insect, or a beetle of the third generation, does not, however, leave its cell in the ground, but remains there until the following spring.

In some cases these beetles have been badly fooled by the weather, showing that their instinct is not infallible. Three years ago we had a very early and severe frost lasting several days. After this frost it became very warm again, in fact we had a second summer lasting many weeks. This warm weather following a severe frost—winter—invited the beetles to leave the ground. Of course all beetles that left their wintering quarters perished from hunger, or later by frost. Knowing the natural history of this insect it is, of course, very easy to account for the fact that few or no potato-bugs could be found in the spring of 1895. Whoever recollects the continuous drouth of the summer and early fall of 1894 will also recollect that the foliage of the potatoes had disappeared almost entirely early in the summer, and that consequently there was very little food for the potato-beetle to produce a third generation. In fact a great number of larvae of the second generation already failed to find sufficient food to mature. Other larvae that had fared better were actually killed upon the heated and baked surface of the ground, not being able to dig their way into such a hard substance. There being no third generation, of course there were no hibernating beetles, and none could be found at the time the new potato plants commenced to grow in 1895. These conditions prevailed in almost all parts of this and adjoining states, and it would have been a very lucky thing if certain localities had not formed an exception; but such was the case, and numerous farms near lakes and rivers, or where the soil retained moisture throughout the summer, not only produced good crops of potatoes but equally good crops of beetles.

In 1895 such places formed centers from which the potato-beetle spread and wherever farmers permitted them to do so, they have again infested large areas. It would have been a very good thing if the state had a law that would have forced farmers to kill the few potato-bugs that were seen in the fields, because an opportunity like the past one, in which an insect could be stamped out, may never occur again, or not for very many years. The season was an excellent one for the potato. The plants had a superabundance of foliage and the few beetles could not possibly cause any injury to the crop. Consequently most farmers did not try to kill them, thus giving the insect a chance to rapidly multiply. In the fall of 1895, potato-bugs could be found in many places and, no doubt, they will again be somewhat injurious in 1896. In other places, however, they are still absent, and with proper pains can be kept away for years. Potato growers should recollect that by killing one potato-beetle in spring, they not only destroy the offspring of that insect, but the offspring of the two following generations. Supposing the potato-beetle killed in spring happened to be a female, able to lay five hundred eggs; the two hundred and fifty females of the second generation would produce at the same rate 125,000 potato-bugs and these in the next generation 3,375,000. Of course it is not likely that all of the offspring would reach maturity and be able to reproduce, still such figures show how rapidly an insect can increase in numbers, and how important it is to nip the evil in the bud by killing the members of the first generation. Besides this it is much easier to kill the few insects of the first brood than to kill the numerous ones of the later broods. As soon as the potato-plants appear above ground they are discovered by the hungry beetles which immediately set to work to feast and to deposit their eggs. A very little Paris-green or London-purple applied at this time, and applied thoroughly and repeatedly, would kill most, if not all, of the potato-bugs in the field thus treated. The expenses, both for poison and labor are very much smaller than later in the season, and if every farmer would share in this work we could keep away the potato-beetle for many years, if not forever. What is necessary, however, is united effort, because one careless or slovenly farmer could breed enough potato beetles in his fields to infest all surrounding farms.

As has been mentioned already the beetles are active and fly about long before their food-plants are visible. It has been found that these beetles can be attracted to the tubers of the plants, and since the potatoes are so cheap this year it would be very easy to attract large numbers of these insects in the spring to baits prepared for this purpose. As the beetles hibernate in last year's potato fields, such baits should be laid in them. All that is necessary is to pile up in such fields small heaps of potatoes, or potato peelings, to attract the hungry insects. If these potatoes are thoroughly poisoned with Paris-green or London-purple, we have a bait which will both attract and kill.

As a general rule farmers are altogether too liberal with Paris-green and London-purple, and if it were not for the fact that the potato-plant can stand a vast amount of such poison, farmers would do much more harm than good by using these poisons in the manner in which they are doing now. A small amount of poison uniformly spread over the plant is what is required and if more is used, it is simply thrown away.

Every potato-grower ought to have in his possession a good spraying machine, as such a machine is useful not only against insects and vegetable diseases, but also for various other purposes. Nor is it necessary to spend much money for such an outfit, as there are many cheap machines on the market, which are at the same time very effective. In using arsenical poisons such as Paris-green, London-purple, or white arsenic, the following rules should be kept in mind: these three substances are mineral compounds of arsenious acids, and consequently very poisonous to all organized matter. To use them properly we must recollect that plants can be poisoned by them as well as animals, and that they have to be diluted in certain proportions with other substances to make them harmless to plants, and yet keep them poisonous enough to kill such insects as eat the foliage covered with them.

PARIS GREEN.

Paris-green is a chemical combination of arsenious acid and copper, and is called by chemists arsenate of copper. It contains, when pure, about 58 per cent. of arsenious acid. Pure, it is insoluble in water, and can be applied either as a dry powder mixed with other substances, or suspended in water. As plants are affected in different degrees by this poison, the exact proportion of it and dilutants can not be given, except in a general way. Some plants, as the potato, can be dusted with quite a large amount of it without being greatly injured, while the same amount would kill other plants, as the plum tree. Plants made sensitive by certain climatic conditions, as by continuous moist and warm weather without sunshine, suffer much more severely from an application of this and similar insecticides at such times than at others. Before applying any arsenical poisons to plants upon a large scale it is always best to try their effects upon a few, so that the mixture can be made just strong enough to kill the insects and not to injure the plants. It has been found that milk of lime almost entirely prevents the injurious effects of arsenical poisons upon the leaves. Milk of lime can be prepared by filling a barrel nearly full of air-slaked lime, and adding a sufficient amount of water to entirely fill the barrel. After standing undisturbed for some time the clear water above the lime is milk of lime. This can be demonstrated by blowing the air from the lungs through it, when it will become milky.

Dry Application.—As a general rule, Paris-green should be mixed with one hundred times its weight of perfectly dry flour, sifted wood ashes, road dust, land plaster, air-slaked lime or some similar substance. To apply this dry mixture it is necessary to dust it over the plants at a time when there is no wind, and when the leaves are moist, as they usually are very early in the morning. In this case most of the dust will adhere to the leaves and remain there for a long time. Still any dry application, except upon a small scale, is always a very wasteful one.

Wet Application.—One pound of Paris-green to one hundred and fifty gallons of water is a safe mixture with which to kill nearly all insects that possess a biting mouth; it will not kill the foliage of any cultivated plants grown in Minnesota. If it should become necessary to spray the same plants repeatedly, later applications may be reduced in strength. As Paris green does not readily mix with water it should first be made into a paste, and then mixed with the amount of water required. Upon the leaves of some plants, as those of cabbage, this fluid will not readily adhere, but in such a case we can readily overcome the difficulty by adding a little dissolved soap to the mixture, or by adding stale milk.

LONDON PURPLE.

This by-product in the manufacture of aniline colors contains about forty-three per cent. of arsenite of lime; the rest is composed of aniline lime, insoluble residue, some little oxide of iron and water. As the material is cheap it would be used much more frequently if it came in convenient packages and not in bulk. At all events it is just as good an insecticide as Paris-green and can be used in the same manner, dry or with water. It is much lighter than Paris-green, and more finely divided, remains better in suspension in water, and can therefore be applied more evenly with less stirring. It adheres better to the foliage and is consequently not readily blown away by the wind or washed down by the rains. As most of the commercial London-purple contains some free and soluble arsenious acid we must add some milk of lime to prevent injury to the foliage. If this precaution be kept in mind we have in this substance a very superior insecticide.

A good proportion in which to apply London-purple is one pound to two hundred gallons of water, with an addition of about one pailful of milk of lime. It is always well to mix London-purple with the water just before use and not to leave the mixture standing over night, as may be safely done when Paris-green is used. In a dry application we can dilute this insecticide with the same substance as we use with Paris-green.

WHITE ARSENIC.

White arsenic, though very cheap, is too dangerous to use, being so readily mistaken for some edible substance on account of its white color, and also because it is more injurious to foliage, as it is to some extent soluble in water. If it has to be used it should be very much diluted, and the mixture should be applied when quite freshly mixed and only with a large amount of milk of lime.

In using such virulent poisons as Paris-green, London-purple and white arsenic it is important to keep in mind the following rules: label the stored material very plainly "Poison"; do not handle the poison with your hands; never apply it against the wind; do not use upon leaves of fruit soon to be eaten; and use it of no greater strength than is absolutely necessary.

The following doses of arsenic are dangerous: two grains for an adult, thirty grains for a horse, ten grains for a cow, one-half to one grain for a dog. In cases of poisoning treatment is never hopeless. For persons give hot milk and water, and tickle the throat with a feather to induce free vomiting. Sugar and magnesia in milk is also a good antidote. Another remedy is also readily prepared: pour together solutions of perchloride of iron and dilute ammonia; the brown precipitate that forms should be strained off and given with water.

There are certain seasons in which our potato-plants suffer more or less from vegetable diseases, or diseases caused by lowly organized plants. It has been found that the use of Bordeaux mixture is a preventive if not a cure. If our potato-fields are infested with the potato-blight or other diseases, and also invaded by potato-beetles or other insects, it is wise to apply insecticides and fungicides at the same time, because this will save time. A good mixture of both is the following: add 2 ounces of Paris-green or London-purple to 22 gallons of Bordeaux mixture. This latter is made by dissolving 6 lbs. of blue vitriol (copper sulphate) in 16 gallons of water, and 4 lbs. of unslaked lime in the other six gallons of water. Mix both fluids after stirring and straining the whitewash. The cost of this mixture is about 1⅓ cents per gallon.

BLISTER BEETLES.

(*Epicauta pennsylvanica* De G.) *and* (*Macrobasis unicolor* Kirby.)

Several species of these beetles attacked potatoes and caused more or less injury in some fields. These beetles were formerly the only insects destructive to this plant and were known long before the Colorado potato-beetle made its way east, and consequently they are frequently called the "old-fashioned potato-bugs." The history of these blister-beetles is a very interesting one. While very destructive to a number of cultivated plants besides the Irish potato, as for instance beans and vetches, they are so only in their winged stage. Their young or larvæ are decidedly beneficial, as they eat nothing but the eggs of grasshoppers. This is the reason that blister-beetles are always more numerous in years following a dry season, as dry seasons are greatly in favor of grasshoppers.

Whenever grasshoppers are numerous we shall soon find that blister-beetles increase in numbers, and as the adults have a very good appetite, but no grasshopper eggs, they destroy a large amount of foliage. In my attempts to grow a number of foreign species of vetches for fodder plants these beetles have been a great nuisance, as they would devour the leaves of such plants just about as fast as they appeared above ground, and only a thorough dusting with poison could save them. The beetle would find such vetches even if surrounded and almost covered and hidden by other plants. As blister-beetles are more or less gregarious they cause much injury to the plants they select for food. They seem to be very stupid, at least they do not use their wings as readily to escape as other insects, and being voracious feeders they can, if absolutely necessary, be killed by an application of Paris-green or London-purple. Yet if the damage they cause is not too great they should not be killed, because their offspring are such great friends to the farmer, assisting him most effectually against the destructive grasshoppers. Nor can they multiply beyond a certain degree, even if the adults have ample food, because their larvæ have to depend upon the number of eggs deposited by the grasshoppers, and if this supply of eggs is small the resulting number of blister-beetles is also small.

These beetles have a peculiar life-history. The female deposits a large number of eggs in a cavity in the soil. These eggs in hatching produce long-legged and very active larvæ, which run about like hunting dogs until they discover the whereabouts of the eggs of grasshoppers. Having discovered them the larva is not slow to devour one or a few of them. This done it throws off its old skin, and being now surrounded by plenty of food the former useful long legs are no longer required and they are replaced in the new skin by rudimentary ones. As these larvæ destroy more eggs than they eat they are of course very beneficial, and blister-beetles, though themselves very destructive, should be protected on account of their beneficial larvæ.

We have several species of such blister-beetles, but all have essentially the same habits. The illustration of the potato-beetle (Fig. 36, Plate 6,) shows also some adult blister-beetles.

They have received this name because they produce blisters upon a delicate skin, being in fact closely related to the Spanish fly, so well known in former times, and even now, as a very important means to draw blisters. Our blister-beetles can be used for the same purpose and are bought by manufacturing chemists.

CABBAGE INSECTS.

The cabbage plant, in all its numerous varieties, has a large number of insect enemies, besides other organisms which cause the plant to suffer and die. Among the more destructive insects that feed upon the cabbage and allied plants, we have a number of moths and butterflies that cause great losses. As soon as the young cabbage is transplanted, it is attacked by various species of cut-worms, which, in most seasons, cut off a large percentage of the young plants, thus necessitating replanting, These cut-worms, as will be shown elsewhere, can be prevented from doing much damage by the use of tin collars. As soon as the young plants acquire a good stand in the soil, other winged enemies appear. Chief among them are two white butterflies that may be observed flying about during the first warm days of spring. They are indeed harbingers of spring and they delight the eyes of all observers so much more because insects of all kinds have been absent for the last six months. These butterflies, though apparently such frail objects, can stand a great deal of ill treatment at this period. It is not uncommon to find them frozen and apparently dead, yet they recover as soon as the rays of the sun warm them back to life. There are two species of such butterflies common everywhere in our state. Both are white, with black markings and more or less yellow on the under side. One of these species is the native cabbage butterfly (*Pieris protodice* Bd.-Lec.). It is a very pretty insect, as shown by the illustration (Plate 8, *a* to *d*). The sexes differ greatly and seem to belong to different insects, as may easily he seen by comparing their pictures. The second species (Plate 7, *a* to *d*), is the imported cabbage butterfly (*Pieris rapæ* Linn.), an insect that, like the English Sparrow, has already driven away the native species in many places, and is doing so now in our state. It was imported into Canada in 1857, whence it spread very rapidly in all directions, becoming, however, more destructive in the more northern states. The sexes of this butterfly also differ, but not nearly so much as is the case with the native species. As both kinds of white butterflies have very similar life-histories, both will be discussed at the same time. To enable those readers who take special interest in entomology to distinguish them, a description of all stages of both species is given below, in smaller type.

IMPORTED CABBAGE BUTTERFLY.

(*Pieris rapæ* Linn.)

The eggs are fusiform and beautifully ribbed longitudinally. They are at first white, but later become yellowish; they are very small and difficult to detect, being usually deposited singly or in groups of two or three upon the outer surface of a spreading leaf, and not upon the cabbage-head.

The caterpillar is of a delicate bluish-green color, with a pale whitish or yellowish stripe down the middle of the back. On each side there is a row of poorly-defined yellow spots on a line with the spiracles. It is very pale when first hatched, but becomes darker with age. It is about 30mm. (1¼ in.) long when fully grown.

The chrysalis is of nearly the same color as the larva, but usually a little paler. It is sprinkled with very small black dots.

The butterfly has white wings. The front wings are tipped with black and have, in the male, a small black spot midway between the center of the wing and the margin. The hind wings of both sexes have a spot on the front margin. Underneath the hind wings are yellowish and the front wings white tipped with yellow, and having two black spots like those on the upper surface of the wings of the female. There is a great variation in this as well as in the native species.

NATIVE CABBAGE BUTTERFLY.

(*Pieris protodice* Bd.—Lec.)

The eggs of this species are slender and pointed very much like those of *Pieris rapæ*. They are greenish-white in color, and are placed on the under side of the leaves. They are about 1 mm. long.

The caterpillars are quite different from those of *P. rapæ*, being greenish-blue with four yellowish stripes running lengthwise. The entire body is covered with small black dots. When first hatched the color is orange, but soon after the first molt the true colors appear.

The chrysalis differs from that of *P. rapæ* in being pale bluish-gray in color, and in having larger black dots. The ridges or prominences are tinged with buff or pink.

The adult is very like that of *P. rapæ*, but has more black on the wings. In the male there is an oblong or trapezoidal black spot near the middle of the front margin, a small black border at the margin of the apex, a row of black spots crossing the wing transversely between the oblong spot and the lateral margin, and the distal ends of the veins are often colored with a small triangular spot of black. The hind wings are plain white. The female has, in addition to the spots of the male, a border of black spots on the lateral margin of the front wings. All the black spots are usually larger, and the base of the wing is usually darkened. The hind wings have a border of dark enclosing poorly-defined lozenge-shaped white spots. In the male, the under side of the front wings resembles the upper, but is usually more pale. The under side of the hind wings is white, sometimes yellowish or greenish. There is usually a dark spot near the center of the wing, and a few poorly defined spots near the margin. In the female the under side of both wings is tinged along the veins with yellowish or greenish-brown. The front wings have pale spots corresponding to those on the upper surface, except the marginal ones, and the hind wings are often plain white with a yellowish cast. This species is subject to even greater variation than *P. rapæ.*

The cabbage butterflies hibernate as chrysalids or pupæ. They are fastened to walls, outhouses, fences and trees in the vicinity of fields or gardens where cabbages grew during the season. Their form is shown in the illustrations. The caterpillars, in selecting quarters for pupation, prefer a perpendicular object protected from rain and snow. For this reason, the largest number of chrysalids are found under the top-boards of fences. The caterpillar, before throwing off its last skin and assuming the form of a pupa, spins a silken carpet upon the object that it has selected for this purpose, and into this carpet presses the pointed tail of the pupa. To prevent them from falling, during this performance, the caterpillars spin silken loops supporting the middle part of their bodies. The chrysalids remain in this position all winter and, as they are well protected by their color and markings, which resemble wood, they are not readily found by their enemies. Still a large number of those seeking shelter near the ground are discovered by their furred and feathered enemies. Among the former we have such beneficial animals as shrews, which, prompted by the scarcity of food in winter, investigate most carefully all places that might contain insects; and as they discover such food not by sight but by smell, even more perfect mimicry of the chrysalids would prove of no avail. The birds that pass the winter in Minnesota are chiefly seed-eating birds and these kill but few pupæ; however, as soon as spring approaches, large numbers of truly insectivorous birds, as creepers etc., pass through our state. These birds find and devour the great majority of such pupæ. Some years ago I had the position of five hundred chrysalids marked on an open board fence inclosing one side of a large vegetable garden. The chrysalids were inspected and counted each month during the winter. The following was the result:

Oct. 1	500	chrysalids
Nov. 1	450	"
Dec. 2	308	"
Jan. 2	296	"
Feb. 3	282	"
March 1	263	
April 2	217	"
May 1	43	"

During the early part of the winter, only the chrysalids near the ground were devoured, while during the spring, the higher ones were selected. The few remaining chrysalids were found in almost inaccesible places under the top-board and in deep cracks between the upright boards. This shows how beneficial birds and animals may be, and also how, with some pains on the side of the gardener, the greater part of such chrysalids could be destroyed, since there is ample time to find and destroy them.

As soon as spring has come to stay and the young cabbage-plants have been transplanted to the garden, we see the few surviving butterflies that have hatched from the hibernating chrysalids, flying about and depositing eggs. In the mean time, however, other eggs have also been deposited on such plants as pepper-grass, shepherd's purse, cresses and allied plants. Even the plants of other families do not escape: for instance, nasturtiums are greedily eaten. Large numbers of cabbage butterflies were bred from such destructive weeds as the Russian-thistle or tumble-weed and on wild mustard.

The eggs of our cabbage butterflies are most beautiful objects and are, as a general rule, fastened near the tip of a leaf. They soon hatch and produce destructive caterpillars which, during their early stages, feed on the under side of the leaf and soon perforate it. The caterpillars of the first brood do not cause much damage, as the plant is a very hardy one, producing a large amount of foliage and growing rapidly; if, however, the caterpillars are very numerous, they are apt to entirely strip the plant of its foliage, thus killing it outright. The greatest damage is done when the head of the cabbage is forming or is already formed. At this time the caterpillars are very apt to eat into it and ruin it for use.

We have a number of broods of cabbage butterflies in our state, but the exact number can not be stated. At all events the butterflies are very numerous all summer, adding sometimes a peculiar charm to the scenery. During the time that clover is in full bloom, they are very numerous, and again when the golden-rods show in perfection. On such days white clouds of butterflies may be seen, especially in places where the ground is damp. Here immense numbers congregate in search of moisture. These delicate looking butterflies are by no means dainty in the selection of food, and places where cattle have passed and dropped liquid manure are crowded with their eager forms. In our western prairies, where the ground is frequently dry for many days in succession, these butterflies will congregate along the shores of lakes and rivers, or even crowd together in places where buildings are erected, and where mortar is made. The moisture seems to attract them.

Remedies.—Knowing the life-history of these butterflies, it is easy to suggest a number of remedies. One has already been given, viz., to destroy, during the winter, as many of their hibernating chrysalids as possible. The comparatively few butterflies that succeed in issuing in spring should also be caught and destroyed. This is not such a difficult matter, for the great majority of the cabbage butterflies issue near the gardens in which the cabbages were grown during the previous year, and as their flight early in spring is not very rapid, it is easy to capture many by means of a net and to destroy them. It would be best to combine sport with this labor by furnishing to boys and girls, a number of cheap butterfly-nets, which any one can make, and by offering a reward for each hundred butterflies captured. We could thus destroy nearly all the butterflies of the first brood, which of course would prevent later broods.

Since the caterpillars of the cabbage-butterflies chew their food, it is, of course, easy to poison them. Two of the best materials for this purpose are Paris-green and London-purple

We should not, however, wait until the plant is large before we apply these poisons, but should poison the young plants as soon as the small caterpillars appear. The foliage of the cabbage being smooth, it is well to add some boiled flour or stale milk to the liquid containing the poison, in order to make it stick better to the leaves. By doing this work thoroughly and in season we shall be successful, but if we wait until the cabbage-head is formed, we must resort to other means. The leaves of the cabbage below the head are, of course, not utilized for food and even the outer leaves forming the head are thrown away as being too tough, and consequently we do not spoil valuable material by spraying or dusting it with poison, nor do we endanger human life. When, however, the head has been formed, and the caterpillars have entered it, then the application of poison is dangerous. To kill caterpillars at this late stage is not a simple and cheap affair. A number of patent medicines have been freely advertised to destroy cabbage-worms. The slug-shot and oxide of silicates are most frequently used. Both do good service since they contain, as the killing agent, Paris-green. Yet all such patent medicines are more dangerous and expensive than the mixtures made by the cabbage grower himself, since he knows the exact composition of the insecticides.

If only a comparatively few heads are to be protected, an application of boiling-hot water has been proposed. This *seems* to be a case of jumping from the frying pan into the fire, and most people seem to think that hot water would kill the plants a little quicker than the worms, yet such is not the case. An application of hot-water will kill all insects but will not kill or injure the plant. It should be applied as hot as possible with a sprinkling-pot. The passage from the sprinkler to the plant will cool the water sufficiently to render it incapable of doing any permanent injury. Of course this is a remedy which can not be applied on a large scale.

A free use of pyrethrum in the following proportions: one part of pyrethrum to three or four parts of flour, is also a very good remedy, providing the pyrethrum is not too much adulterated or otherwise spoiled. The powder should always be kept in an air-tight tin box, otherwise its active principle, an essential oil, will soon escape. As it is, some of our retail druggists expose it in open barrels in their show windows with flaming posters to attract purchasers. Of course if kept in this manner, it loses all virtue as an insecticide. In Europe, they keep the dried flower-heads until the powder is needed, when they are ground. It can also be utilized in the form of tea, a decoction, an alcoholic extract, or a fume, and will be found very useful in certain cases. Pyrethrum is now produced in California on a large scale and is sold under the name of buhach. The great objection to this substance is its expense. It costs sixty cents a pound if bought of the Buhach Manufacturing Co., of Stockton, Cal., but as the powder is very light, a pound of it will cover a large number of plants.

The use of lime and carbolic-powder is highly recommended by Prof. Riley. It should be sprinkled upon the plants early in the season, since it both kills the larvæ and drives away the adults that come to deposit eggs. The method of preparation is as follows: twenty parts of superphosphate of lime are mixed with three parts of fresh air-slaked lime and one part of carbolic powder, which is made by thoroughly impregnating saw-dust with carbolic acid. It should be applied three or four times at intervals of three days.

Kerosene-emulsion of extra strength and forcibly applied will also kill large numbers of caterpillars, but it is not as effective as could be desired.

But all these applications of poison will remain theroretical if cabbages bring no better prices than in 1895, for the application under such conditions would cost more for time, labor and material than the crop could be sold for. All remedies must be applied, no matter what they are, throughout the infested region, otherwise a few negligent farmers can breed enough cabbage butterflies to infest the whole neighborhood.

Enemies.—Both of our species of cabbage butterflies have a large number of enemies. Besides the animals and birds already mentioned, there are a large number of cannibal insects that reduce their numbers, and besides these there are a large number of true parasites that infest their larvæ and pupæ. The caterpillars of both kinds of cabbage worms are frequently destroyed by a small, black, four-winged parasite, the *Apanteles glomeratus* Linn. The maggots of this parasite, after living in the interior of the host, eat through the skin, and spin about themselves a yellow silken cocoon, about an eighth of an inch long. Many such cocoons are placed side by side, and thus form plainly visible masses fastened to the infested plants or upon other objects in their vicinity. Fig. 39 shows a species of *Apanteles* bred from the army-worm, a single cocoon, and a large number of them crowded together.

Such cocoons should not be destroyed, as the small wasps issuing from them are our best friends. As early as the autumn of 1881 the writer introduced these parasites from Europe, where they did wonderful execution in the cabbage fields crowded with caterpillars.

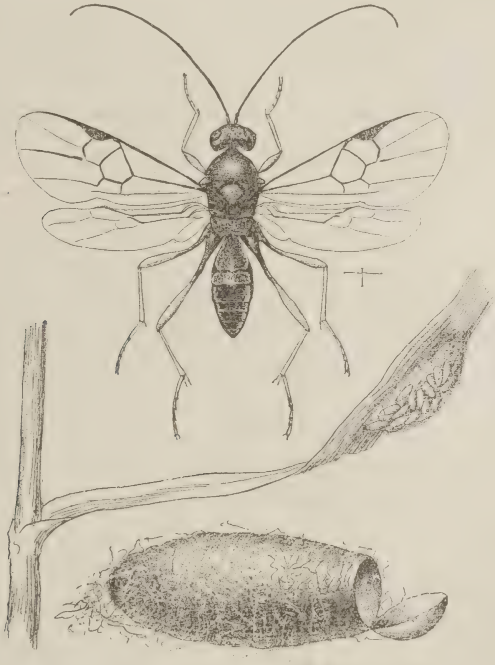

Fig. 39.—*Apanteles*, n. sp., greatly enlarged, the line below showing natural size; its cocoons, natural size, fastened upon leaf, and also a single cocoon greatly enlarged. (Original).

Many pupæ of both species of cabbage butterflies are infested with another parasite, which is a minute, green wasp (*Pteromalus puparum* Linn.). Large numbers (40-50) of them find sufficient food inside a single chrysalis. Many other friendly insects come to our assistance and in some seasons are sufficiently numerous to check our enemies.

THE ZEBRA CATERPILLAR.

(*Mamestra picta* Hav.)

One of the handsomest caterpillars that is found in the United States is frequently found upon the cabbage plant. Though very beautiful, it becomes a very destructive pest when numerous. It is intensely black, with zebra-like markings of sulphur yellow, mixed with white spots. Its head, legs, and prolegs are bright red. This caterpillar, as well as its equally beautiful moth, is illustrated on plate 7, e and f. On account of the contrasting stripes upon its skin, the insect is often called the zebra-caterpillar of the cabbage. It belongs to the same family as the cut-worms, but it does not possess their habit, as it lives freely exposed upon the leaves of the cabbage. As far as remedies are concerned, an application of the same substances mentioned before will be effective.

THE CABBAGE PLUSIA.

(*Plusia brassicæ* Riley.)

There are still other caterpillars belonging to the owlet-moths that injure the cabbage plant. The common cabbage plusia (*plusia brassicæ* Ril.) is sometimes very destructive. The slender, pale-green caterpillar, with pale, longitudinal stripes, is distinguished from the zebra-caterpillar by its peculiar method of locomotion. When disturbed, it moves like a measuring-worm with a sort of looping gait. The moth has dark-brown front wings shaded with light-brown and gray. A light-colored stripe extends from the white patch near the center to the anterior border. The hind wings are dark-brown, lighter towards the base, fringed with a white border including dusky patches at the end of each vein. It is distinguished by having a silvery mark upon its front wings. Though a night-flying insect, it flies about frequently during the day and can consequently be seen, although its motions are very rapid and irregular. The caterpillar, instead of entering the ground like the zebra-caterpillar, spins a loose silken cocoon among the foliage of the cabbage, inside of which the pupæ is plainly visible, as shown in the illustration on plate 8, e and g. Another plusia, much more gaudy in coloration, also feeds upon the cabbage. There are a number of annual broods of these destructive insects.

THE CABBAGE PLUTELLA.

(*Plutella cruciferarum* Zell.)

Looking at the illustration on plate 7, we discover some minute worms and cocoons, which are the early stages of a small moth, also illustrated (g, h, i,). These insects frequently become very numerous and consequently destructive. A description of the early stages of this insect is given below:

The slender caterpillar is pale-green in color, about 10 mm. or a little more than a quarter of an inch in length. It is nearly cylindrical in form, but tapers slightly. When disturbed, the very active caterpillars squirm about in a lively manner, wriggling themselves off the leaves and dropping to the ground by means of a silk thread which remains attached to the plant. The white cocoon is placed on the underside of the leaf. It is fusiform in shape and is made of very delicate meshes resembling lace. The apple-green pupa is visible through this cradle made of open meshes. The moth is a very small narrow-winged insect measuring with spread wings, about half an inch from tip to tip. The color of the upper wings varies from light to dark-brown, with a wavy, white, narrow band along the posterior border. In some cases, this white, wavy band is very obscure. With wings closed, the moth appears to be very small, resembling a small bit of twig. The wings are closed roof-like, over the abdomen, and the two white margins of upper wings now meet, and united with the white upper surface of the thorax and head, produce a very conspicuous dorsal stripe. The insect hibernates in the chrysalis stage among the rubbish of the cabbage field, and a few young caterpillars may be found early upon the plants just set out. We have several annual broods and under favorable conditions, the insects could cause considerable damage, yet this does not happen very often as the insect is to the taste of many parasites. The illustration upon Plate 7, *k*, shows the most common parasite of this moth; both male and female parasites (*Limneria tibiator* Cr.) are given.

As far as remedies are concerned, those applied against the other cabbage insects are sufficient; they must, however, be applied very early in the season.

OTHER ENEMIES.

It would seem from the above that our cabbages have but a poor show of coming to maturity, yet the insects here described, are, by no means, the only enemies of the plant. There are a number of minute jumping flea-beetles that injure the young plant and frequently kill it. A number of larger bugs seem to enjoy the sap of this succulent vegetable as well, and cause more or less injury and, later in the season, the plant is very badly infested with leaf-lice (*Aphis brassicæ*).

These lice increase in numbers very rapidly, as explained elsewhere, and cause considerable damage. They do not injure the head directly or to such a degree as the other insects, but by absorbing a large amount of sap, weaken the whole plant.. Moreover, a lousy head, even that of a cabbage, is not an appetizing thing and finds no ready sale. If it were not for the assistance of a number of beneficial insects, these leaf-lice would soon increase to such an extent that cabbage-growing would hardly be a paying business. Among these beneficial insects is a gaily-colored fly, about the size of our common house-fly, but striped with yellow and black. It lays its eggs near a colony of the appids or leaf-lice. From the eggs issue tiny, soft, yellow maggots, which attack the appids and suck the juice from their bodies. These maggots, at first very small, grow until about one-eight of an inch in length, when they settle in quiet places and change to puparia. Shortly after this, the adult flies (*Syrphus-flies*), issue ready to repeat the process.

Another very beneficial, though a much smaller insect, is a parasite which deposits an egg in the living louse. The grub or maggot which hatches from the egg, at first seems to eat the less vital parts of the host but afterwards the entire contents. It now lines the inside of the empty skin of the louse with a very thin layer of delicate white, silken threads, and in doing so, distends and rounds it. This done, a circular lid is cut out from the inside but not entirely separated. The adult wasp, an *aphidiust*, would otherwise remain a prisoner, but now all that it has to do to gain liberty is to press against the lid, from the inside of the cocoon, and the parasite is ready to start another cycle of usefulness. Such swollen brownish aphids are often seen among the living ones, and attract our attention by their roundness, or by the circular hole through which the parasite issued.

When cabbage lice become very numerous, they should be destroyed by the use of kerosine emulsion; one part of the emulsion to fifteen or twenty parts of water is a good proportion. Since, however, the lice are found chiefly upon the under side of the leaves, and are, moreover, well protected by a powdery, waxy material which sheds water, this spraying is only successful if very thoroughly done and with a strong force-pump. It is best to spray first with a strong solution of soap so as to partly dissolve the protecting material; this done, the emulsion can act much better.

SAW-FLIES.

Saw-flies, sometimes called slugs, are members of the order of Hymenoptera, which includes such insects as bees, wasps, ichneumons, ants, chalcids, gall-flies, saw-flies and horn-tails. The adult hymenoptera are not frequently observed by the farmer and gardener, nor are their early stages noticed, as they are usually passed in well-hidden nests, or inside other living insects. Only the larvæ of saw-flies form an exception, as these live often freely exposed like true caterpillars upon their food-plants. They resemble caterpillars so closely that they are usually called "false caterpillars." They are distinguished from true caterpillars of butterflies and moths by having a larger number of legs, possessing besides the six jointed or true legs from twelve to sixteen pro-legs, while the caterpillars of the former are usually provided with only ten pro-legs besides the true legs. Many of the saw-fly larvæ have the habit of curving the posterior half of the body sideways, so as to somewhat resemble a snail, (Fig. 40). This habit may afford them some protection from the attacks of

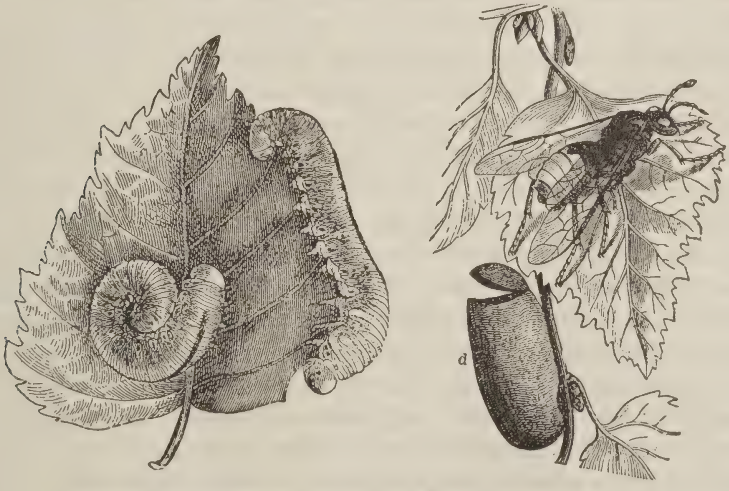

Fig. 40.--Large Saw-fly; adult, larvæ and open cocoon.

parasitic and predaceous insects, as the snail-like appearance may, perhaps, cause some of their enemies to pass them by. A better protection, with which most false-caterpillars are provided, is their power to secrete and eject an acid fluid from small pores in the skin. Whoever has passed through a wind-break of willows infested with the large, pale-green saw-flies of the American Cimbex, will have felt the rain of acid fluid produced by the worms overhead. Other saw-fly larvæ are covered with a downy material that effectually hides and protects them, while still others produce genuine galls like the willow-apple, or live inside of solid wood. While in this larval stage some of them do great damage by devouring the foliage of trees and various plants. Some gnaw holes through the leaf, others eat the entire leaf, while still others eat only the soft parts, leaving the skeleton of the leaf. Though a few species form galls and feed inside of these, they all spin, when ready to pupate, a papery cocoon, inside of which they change to pupæ. These cocoons are hidden in various places, below the surface of the ground, just above it, or inside of various other substances, while some are fastened to the food-plant itself. In this condition, most of them pass the winter, some of them remaining larvæ until spring-time when they change to pupæ and soon after to adults. They are, most of them, small insects with transparent wings and broad squarish heads and robust bodies. Some, however, are very large, as for instance, the worst enemy of our wind-breaks, the American Cimbex, which is an insect almost as large as a big hornet. When flying in large numbers over the tops of willows, just before laying their eggs, it requires strong nerves to catch them with the fingers. Very few persons will dare to do so, yet the insects can not sting. They possess in place of this defensive, sometimes offensive, organ, a pair of saws by means of which they split leaves for the reception of their eggs. Even this organ is lacking in the males, and these insects can, consequently, only bite with their mandibles but can not seriously injure the fingers that hold them. The name saw-fly is, like many common names of insects, misleading, for they are not flies at all but wasps. The term saw refers to the small, double saw of horny material, which is fastened to the ventral side of the abdomen, and which is used to split leaves for the purpose of forming pockets or receptacles for the eggs. These eggs have the peculiar property of swelling when they come in contact with the sap, and are thus securely kept in position inside the small pockets made by the saws.

The larvæ or false-caterpillars of these insects often cause great damage by devouring the foliage of our shrubs, shade and fruit-trees, nor does the grain and small fruit escape. The willows and poplars used as wind breaks are their favorite food-plants in Minnesota, and here they multiply to such an extent as to very seriously injure the trees.

CURRANT INSECTS.

THE IMPORTED CURRANT-WORM.

(*Nematus ventricosus* Klug.)

The most destructive insect that attacks the currant is the above named saw-fly which feeds indiscriminately upon all kinds of currants and gooseberries. A second species, a native of the United States, is only occasionally found in Minnesota, mainly upon the wild species of the above named plants; but only in extreme cases does it become numerous enough to cause damage. The imported species is supposed to have been accidentally introduced into this country about the year 1857, and has since spread over the greater part of the United States and Canada. The eggs are glued to the main-ribs of the leaf as shown in Fig. 41, and not inserted into pockets as is usually the case with saw-flies. This insect furnishes an excellent illustration of the rather general rule that an organ not used, soon becomes rudimentary. Like all saw-flies, the female of this insect possesses a pair of saws, but these consist simply of the blades, and are minus the real teeth, which are reduced to mere dull projections. In from four to ten days, the egg hatches into a very small whitish caterpillar with a white head ornamented with black spots on each side. This color, however, changes to green as soon as the caterpillars begin to feed, and after their first skin is shed, the head becomes black and many black spots appear on the body. This coloration persists until the last molt when the insect becomes grass-green. The head, however, retains the black spots on each side. The length of the worm is now about three-fourths of an inch. While growing they, at first, skeletonize the leaves; later they eat the entire leaf, with the exception of the ribs, and at last, they devour immense quantities of them, often completely stripping the bushes of their foliage. If this is repeated year after year, the plants produce less and less fruit and eventually die. The larvæ now decend to the ground, in which they spin a small, oval cocoon of brownish silk, either just below the surface of the ground or among the leaves and rubbish that collect below the plants. Inside these cocoons they change to pupæ and later to adults, which are ready to issue as winged saw-flies during the last of June or in July, sometimes not until the first of August. They now pair and produce a new generation of injurious worms, which in turn produces a second one, the adults of which do not, however, issue until the following spring. As the two broods overlap, we can find larvæ of all stages during the greater part of the summer.

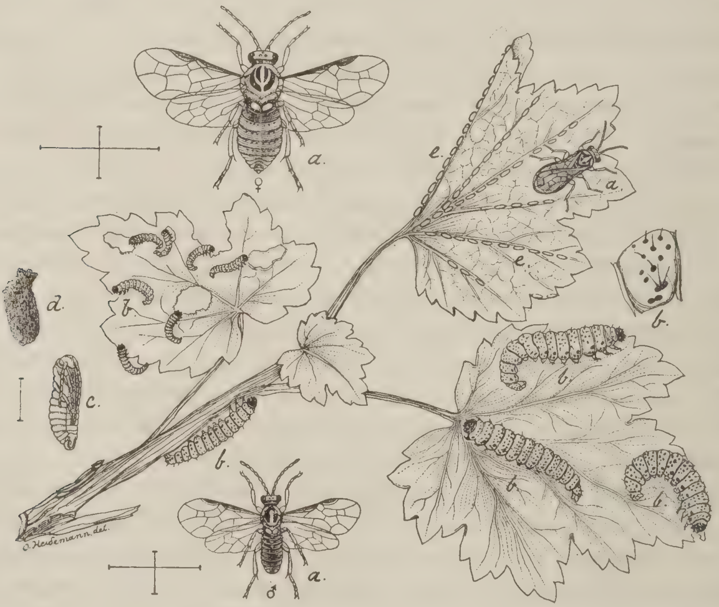

Fig.41.—Imported Currant-worm; *a*, male and female saw-fly; *b*, larvæ of different sizes; *c*, pupa; *d*, cocoon; *e*, eggs. Original.

THE NATIVE CURRANT-WORM.

(*Pristiphora grossulariæ* Walsh.)

The native species is in all its stages about two-thirds the size of its imported relative. The larva differs from the imported one in color, being uniformly pale-green with the exception of the head, which is black before the last molt, but becomes partly green afterward. It differs also in its habits. Instead of spinning its cocoon under ground or among fallen leaves, it attaches it to the twigs or leaves of the bushes upon which it fed. The eggs are laid on the wood instead of on the leaves, as is the case of the imported species. The adults emerge as winged insects early in September, and lay the eggs for the following spring-brood. The reason for depositing them on the twigs is apparent, for if they were placed on the leaves, they would soon fall with them to the ground and perhaps be destroyed.

Enemies.—The natural enemies of the currant-worms are not always adequate to keep them in check. There are some cannibal-bugs that kill them by sucking the juices from their bodies. Several small, true parasites have also been bred from them, as well as a Tachina-fly, but these friendly insects prove of very little aid to the fruit-grower. There is, however, a very small hymenopterous insect that deposits eggs in the eggs of the imported currant worm, and so effective is its work in some seasons that but few eggs of the injurious currant-worm escape destruction. These friends are so exceedingly small that they are barely visible and their presence is only detected by their good work.

Remedies.—The great remedy for most saw-flies is white hellebore. This is fairly cheap and can be obtained almost anywhere. It is easily applied by a dusting-box made as follows: a tin box, holding a quart or less, and having a finely perforated cover like a pepper-box, may be fastened to the end of a pole or stick, from five to six feet in length, by driving two or three screws through the bottom of the box into the wood. This box should be partially filled with powdered hellebore diluted with flour or sifted road-dust, in the proportion of one part of hellebore to two or three parts of flour. If it is not possible to secure such a box, then place some of the insecticide in a muslin sack and tie this to the end of a stick. By beating this stick with another one the dust can be uniformly scattered over the plants. It is best to stand on the windward side and to choose as quiet a day as possible for the work, as the powder blows away very easily and wastes. The caterpillars are somewhat sticky and the dust readily adheres to them. The operation of dusting is most effective when the plants are still moist with dew. Although the dry powder is very effective, the result is just as certain and the application is more economical and safe, if the hellebore is applied with a liquid in the form of a spray, or with a syringe, or even with a sprinkler. It should be used in the proportion of one pound of powder to twenty or twenty-five gallons of water. In the form of a spray, it will not blow away and will cling much better to the plants and insects themselves. It kills both by contact and by being a poison. Sometimes it happens that the worms are doing great damage and no hellebore is at hand, or it is impossible to procure it in time to save the foliage and berries. In such cases, Paris-green or London-purple may be used, but never without milk of lime. The use of this is explained in the article on potato-bugs. For the currant-worm it should be diluted and used in the proportion of one pound of the powder to two-hundred gallons of water. Our gooseberry bushes are very apt to be troubled with blights. In view of this it is very good to mix Paris-green with Bordeaux-mixture, and at one spraying to kill both worms and blight. We should use two ounces of Paris-green or London-purple to twenty-five gallons of Bordeaux-mixture. When this mixture is used, we do not need milk of lime, for the lime of the Bordeaux-mixture answers the purpose of neutralizing any free acid that might be in solution. The following is the formula for Bordeaux-mixture: copper-sulphate (blue-vitriol), 6 lbs.; unslaked lime, 4 lbs.; water, 22 gallons. Put the copper in a sack of burlaps and suspend it in 16 gallons of water until it is dissolved. Slake the lime in the other six gallons of water and strain the thin whitewash into the copper solution, stirring it well. Keep it well stirred and use at once.

Besides the insects already mentioned as being very destructive to the currants and goosberries, there are still others, some of which are always injurious while others only in exceptional cases. Fig. 42, Plate 8, shows the leaves of currants infested with the **Currant-louse** (*Aphis ribis* Linn.). These insects as shown elsewhere, imbibe the sap of plants, thus weakening them greatly if at all numerous. In some cases, as in the present one, they cause a distortion of the leaves in the form of discolored, bladder-like hollows, in which the lice are more or less protected. In extreme cases, these distortions become almost true galls. The remedies given in the article on leaf-lice should be employed.

We find not unfrequently peculiar thorny caterpillars defoliating the currants and gooseberries. In some cases they become decidedly numerous and correspondingly injurious. This us ually happens late in summer or when foliage and flowers for the next season are being formed by the plants, in the shape of buds. Wherever these thorny caterpillars have been numerous or have denuded the canes of their foliage, we shall find that no fruit is produced in the following season. The adult of this caterpillar is a very pretty butterfly, the **Grapta butterfly** (*Grapta comma* Harr.) illustrated in Fig. 43.

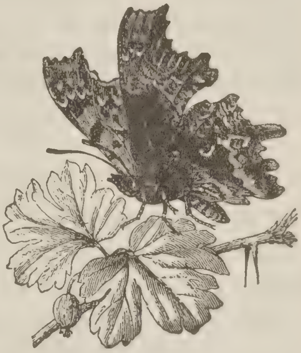

Fig. 43. Currant-butterfly. Natural size.

Still another insect is sometimes found upon these plants, and even a few insects of its character can cause considerable damage. The insect is the **Four-lined Leaf-bug** (*Poecilocapsus lineatus* Fab.). It is a true bug, or a sucking insect, as may be seen in Fig. 44. The adult insect is distinguished by its bright orange-yellow color marked with four black stripes upon the dorsal surface. The earlier stages, including the pupal stage, are all very active and are rendered prominent by their vermillion-red color marked with black.

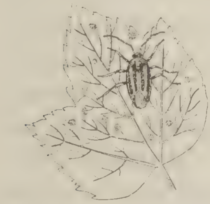

Fig. 44. Four-lined Leaf-bug. Original.

This leaf-bug seems to prefer our numerous wild species of currants and gooseberries, and is as yet not found very frequently in our gardens. But where it is found at all, it causes considerable damage, as it injures, in all its stages, the most tender leaves when they are just opening. It seems that a large amount of poison is injected into the wound made by the slender beak of the bug, as the substance of the leaf near the wound always turns brown. Terminal leaves injured by this insect curl up in very peculiar shapes and soon become discolored and die. These curled leaves afford an excellent shelter for the insect, and make it very difficult to apply remedies. As these insects do not chew their food, we have to apply such remedies as kerosene-emulsion, which, however, has to be used as strong as one part to five of water, as the bugs are exceedingly hardy. Clean culture is always advisable. This with pruning, late in autumn, or very early in spring, will prove effective, as the eggs are always deposited near the tips of the canes of that season's growth.

THE CURRANT-BORER.

(*Sesia tipuliformis* Linn.)

The currants in all their varieties, as well as the different kinds of gooseberries, have no greater enemy than the above borer. The damage it causes is so much greater than that inflicted by other enemies of these plants, because a whole cane, even the whole plant, may be killed by a single borer, nor can its work be noticed until the injury has been done. Like so many of our destructive insects it was introduced from Europe with the plants that it destroys, but it is now much more injurious here than in its original home. The insect is illustrated in Fig. 45 on Plate 5, where its work, the larva, empty pupa and adult are given. A glance at the latter shows that it is a beautiful moth. When seen in June upon the bright foliage of currants, it is indeed an elegant insect, in whatever position it may be observed. It shows to the greatest advantage, however, when making love to its mate. In this case the male dances about very gracefully, rapidly opening the fan-like feathers at the end of the abdomen, and as the whole insect is clothed in glossy scales it reflects all the prismatic colors. The adult insect, as seen in the illustration, is quite different from ordinary moths, having its wings but partly covered with scales, the uncolored parts being glassy, which is the reason why such moths are frequently called "glassy-wings". Such moths resemble flies and wasps, and are frequently mistaken for such; in fact they sometimes mimic such stinging insects so effectually that even a well trained entomologist has some scruples about capturing them with the hand. Some of these moths carry this resemblance so far as to even threaten to sting, though never possessing such an organ. This currant-borer, however, does not possess a tapering body, but its posterior end is ornamented with a fan-like covering of scales. The wings have black markings, as seen in the illustration, with purplish reflections; the body is ringed with yellow; the thorax is also ornamented with yellow lines. The female, though resembling the male very closely, is not so active; she has other and more serious business on hand than dancing, since she has to deposit her numerous and rapidly developing eggs. For this purpose she selects canes at least one year old. The beautiful egg, possessing the usual form of eggs of lepidopterous borers, is fastened most frequently in the angle made by the leaf and the cane. Other eggs are found below the loose scales found upon canes, and in the cracks of bark. These eggs soon hatch and the young caterpillar or borer eats its way into the interior of the cane, penetrating to its very pith. Here, apparently well protected against all enemies, the caterpillar has a congenial home, surrounded with plenty of food, and soon a long tunnel, sometimes several feet in length, shows that the appetite of this recluse does not suffer by its isolation. We never find more than one caterpillar in each burrow, showing that the females have been very careful in exploring the cane before entrusting it with an egg. The caterpillars grow but slowly, and at the approach of winter are not much more than half grown. They now prepare for the cold season by retiring as deep in their tunnels as these will permit, and surrounded by frass and chewed up fibres of the pith and wood, they are as well protected as required.

The larva possesses the usual form of caterpillars of this family of moths. It is of a yellowish color, with a brown head, as shown in the illustration, which also shows the piliferous spots and hairs.

When the warmth of the sun in spring starts vegetation, and soon after the flowers of the currants open, the hibernating larva also feels imbued with new life and energy, and rapidly grows to its full size, being after the long enforced fast much more voracious than during the previous season. This great appetite is soon felt by the plants; many canes with flowers and partly expanded foliage show by their small leaves and their yellowish appearance that they are suffering from the insidious enemy in their interior. Most of the canes attacked soon die, and are broken down by the first wind or heavy rain; the larger ones may remain alive for another year, but are certain to die later, as a hole through which the winged borer has issued permits the entrance of rain, and this moisture, in combination with parasitic or other fungi, soon starts decay, as may be seen by the black interior of such tunnels.

The larva, when full grown, prepares for pupation by first eating a hole through the cane, so as to permit the future moth to escape. If this were not done the moth, which has no mouth, or at least only a rudimentary one, and which is consequently unable to eat its way out of the cane, could not leave at all. After providing for such an exit this hole is slightly closed from within with bits of wood, and now the larva changes to a chrysalis or pupa, as is shown in the illustration.

The pupa is of a light brown color. In the illustration an empty one is shown projecting from the hole or exit prepared by the caterpillar. The peculiar spines enabling it to move are also shown. The two long processes seen in the illustration are simply the sheaths in which the long antennæ were hidden. Before the moth issued these were soldered to the sides of the pupa, and were not more prominent than the encased wings and legs.

Towards the end of May or during June, according to the climatic conditions prevailing at the time, the pupa forces its way partly out of the tunnel of the cane and pushes away the plug closing the exit. This movement of the pupa is made possible by the rows of spines found upon its abdominal segments. The pupa is now partly outside of the cane and is held in position by its posterior portion. It now splits open in the usual manner upon its back and the winged moth appears.

To this account of the life-history of this injurious borer may be added that no parasites have as yet been discovered in Minnesota. Yet several times a silken cocoon was found in a tunnel which apparently had been recently inhabited by a borer. The small wasp issuing from this cocoon is distinguished by blackish wings, black body, and bright red abdomen; it is a species of *Bracon*. In some cases mites were found upon the dead caterpillars inside the burrow, but whether these had killed the caterpillar, or had simply come to feast upon its dead body, is impossible to say, though most likely the former was the case.

Remedies.—An insect so well hidden as this borer can not be reached by any poison, and our only hope is to prevent it from entering at all. This seems to be very feasible, as the egg is deposited upon the cane and not forced below the bark, as is frequently the case with borers belonging to the order of beetles. When the young currant-borer leaves the eggs it has to come in contact with the bark, through which it has to eat its way. If, therefore, the bark could be poisoned, we should have a sure remedy, but when it comes to a practical application of this spraying, it will be found that currant-bushes are rather difficult to spray so thoroughly as to coat the canes in a uniform manner. I have tried repeatedly to coat the canes with arsenical poisons before the foliage had appeared. There was no difficulty in doing so, but it was found later that the plants sprayed in this manner contained just as many borers as those not sprayed. This is owing to the fact that at the period when this spraying can be done we usually have the most frequent rains. There is, however, another remedy, which is easily applied, and which—if carefully carried out—will eradicate this insect from gardens. Canes that harbor the borer can always be detected and if found should be pruned below the lowest part of the tunnel. The canes that have been cut off should be taken away from the garden and burned as soon as dry, or if such pruning is done late in the spring the canes should be covered up with soil, so as to prevent the moths from leaving. In no case should they be left on the ground, because cutting them off from the plant does not kill the borer. The pruning is also otherwise of benefit to the currants, which are usually permitted to grow too much wood and become too old for the benefit of good crops of berries.

Some varieties of currants and gooseberries are stated to be free from borers. If such is the case the writer has not seen them. It has also been claimed that black-currants are not to the taste of such borers, but I have seen that they not only did not escape the ravages of this pest, but were even preferred to the red and white currants that grew in their immediate vicinity.

LEPIDOPTEROUS BORERS.

Borers are very destructive insects, and in most cases are not easily combatted. For instance, if they bore into the trees, we can not apply the remedy of pruning, but have to resort to other means. As a general rule it is easy to detect the presence of borers in trees, either by the discoloration of the bark, or by the frass that is pushed out through small holes. In other cases the tree secretes certain sticky substances to cover the wounds, and these indicate the locality where the borer is hiding and at work. Many reports were received in which complaints were made about such borers, and these show that a number of these insects are found in Minnesota. In some sections of the state the soft maple suffers greatly by the **Maple-tree borer,** a beautiful insect of about the same size as our currant-borer but much more brightly marked with red and yellow, (Fig. 46). It seems that whenever a tree-box has injured the bark of young trees a breeding-place for this borer has been started, and the insects breed year after year in such places until the tree succumbs. Maple tree borers are almost invariably found in this situation, and this being the case the remedy is simple. The pruning-knife should be freely used; all the caterpillars and their burrows should be cut out, and the whole infected place should be covered with some pruning wax and bandages. If such wounded spots on maple trees are coated every spring with soap, in which a little lime and Paris green is mixed, the female moth would not be attracted. In fact, a coating of soap is an excellent prevention against all borers, and trees thus protected will escape while others suffer. It is best for this purpose to scrape off all loose bark, and besides washing the trunk and larger branches with a thick solution of common soap, it is well to leave a piece of hard soap in the crotch of the tree, so

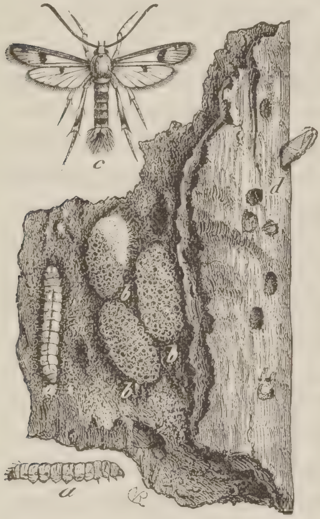

Fig.46—Maple-tree borer; *a*, larvæ; *d*, pupa: *c*, moth; *b*, cocoons. After Riley.

that each rain will wash down some of it, and thus keep the bark more or less coated with this offensive material to insects.

Many complaints have been made about **borers injuring the plum trees.** Evidently several species are involved, but as only young caterpillars were received it is impossible to give the name of the culprits. These caterpillars injure not only large plum trees, but even the seedling plants one year old. The illustration (Fig. 47, Plate 8), shows the work of such a borer; the stem in this case was too small to permit it to burrow, but it had been forced to work from the outside. The still small worm was found in this partial burrow ready to hibernate. The largest number of borers work just below the surface of the soil. Others, and perhaps of a different kind, enter the trunk and even the larger branches. They are readily detected in such an exposed position, and as readily removed with a knife. In some cases, when the knife can not well be used, the borer can be reached with a piece of flexible wire and killed in its burrow; but this is not a wise plan to pursue, as the decaying insect below the bark is apt to badly affect the neighboring parts of the trunk. Remove the borer and cover the wounded spot with wax to prevent the growth of injurious fungi.

The illustrations (Fig. 48 and 49), show two other borers, which are destructive in Minnesota.

The **Red oak borer,** (*Trochilium luggeri* H. Edw.) was very common some years ago, seriously injuring the red oaks in St. Anthony Park. Every tree would show numerous holes from which these moths had issued, and in many cases the empty chrysalids were still projecting from them. The moths issued towards the end of May and throughout the month of June, and as some trees harbored hundreds of such borers in the trunk and larger limbs, many were killed. The perfect moth is a very beautiful insect, mimicking rather closely a wasp. It is very active, running rapidly over the trunk of the tree during the warmest part of the day, but it is very shy and difficult to capture. Strange to say, during the last four years not a single moth has been seen, nor is any of their work to be found in the same place where they

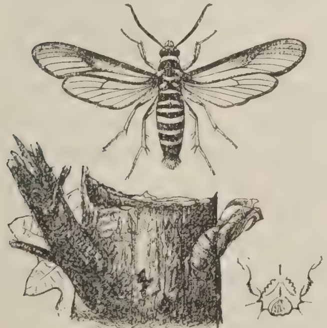

Fig. 48.—Red oak borer, showing moth and empty pupal case. Original.

abounded six years ago. It is true many of the trees infested by them were cut down and burned, yet many more remained. What has killed these insects so effectively is not known. A description of the moth follows in smaller type, so that the readers not interested in such matters may skip it.

Trochilium luggeri H. Edw. Upper side of head black, orbits of eyes bright lemon-yellow. Face black. Palpi black at the base, otherwise lemon-yellow. Thorax with the disk black, with short erect downy hairs. Collar, patagia, spot at base of the wings, and a broad streak at base of the thorax conspicuously lemon-yellow. Antennæ chestnut-brown above, dull orange beneath. Tibiæ orange, tarsi somewhat of a darker shade. Abdomen black, anal tuft pale orange, with bright yellow band at the posterior edge of all segments, those of the posterior segments much widened. Fore wings thinly clothed with scales, the costa narrowly dull orange, as is also the oblique rather indistinct discal mark at the end of the cell. The space from vein 2 to vein 5 clear of scales behind the cell. Hind wings with the anterior margin dull orange. Fringe of both wings brownish. Under side of fore wings with the costa lemon-yellow. Length of body 20 mm. Expanse of wings 35 mm. (Fig. 48).

THE ASH-TREE BORER, (*Trochilium fraxini* Lugger)is another borer that is very common in the prairie regions of Minnesota and South Dakota. It effects the ash, and is a very serious hindrance to the growth of the tree. Wherever this tree is utilized for windbreaks or for shade trees, it will soon be attacked by these borers. As a general rule they do not permit trees to reach much of a size, but soon cause them to break down entirely. All parts of the trees are infested, though the borers are most usually found just below the surface of the soil. Young trees always succumb, while larger trees will survive many years. The adult of this borer is a moth that resembles very closely a paper-wasp, as may be seen by studying its picture, Fig. 49. The moth resembles an eastern species of clearwings which also infest the ash. A description of our species is given below:

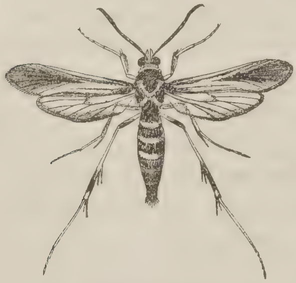

Fig. 49.—Ash-tree borer. Original.

Trochilium fraxini Lugger. The head is grizzled black above with the base, palpi and antennæ dark orange. Coxæ black, tibiæ and tarsi orange, the posterior portion of the tibiæ broadly banded with black. Thorax with the disk black, with rather long and erect hairs. Collar, patagia, a large spot at the base of each wing, and a narrow streak over the posterior part of the scutellum lemon-yellow; all these spots with the exception of those at the base of the wings are edged in front with dark orange. Abdomen black, banded with yellow at the posterior edge of each segment; sides of posterior five segments orange, the orange extending almost over the whole surface of the last three. Fore wings covered with scales, except a narrow portion from base to cell, and some very small spaces immediately behind the cell. Costa and internal margin coppery-brown. Outer margin broadly brown, shaded with purplish copper. Discal mark large, almost rounded. At the base all the veins are stained with bright scarlet orange, and there are some scales of the same color below the costa. Beneath the fore wings are lemon-color on the costa, shading into orange towards the center of the wing, and into brown on the outer margin. Discal mark orange. Hind wings with a coppery sheen. Fringes of both wings brown. Length of body 15 mm. Expanse of wings 30 mm.

Many **other borers,** the caterpillars of larger moths, infest our trees. Prominent among these is *Cossus centerensis* Lint., *Prionoxystus robiniœ* Peck., and *Prionoxystus querciperda* Fitch. To show their general appearance illustration (Fig. 50) has been prepared, in which the different stages of the last named moth are given. The specimen from which the illustration of the female was made was found at noon on June 10. This female moth had just left the pupa, and her wings

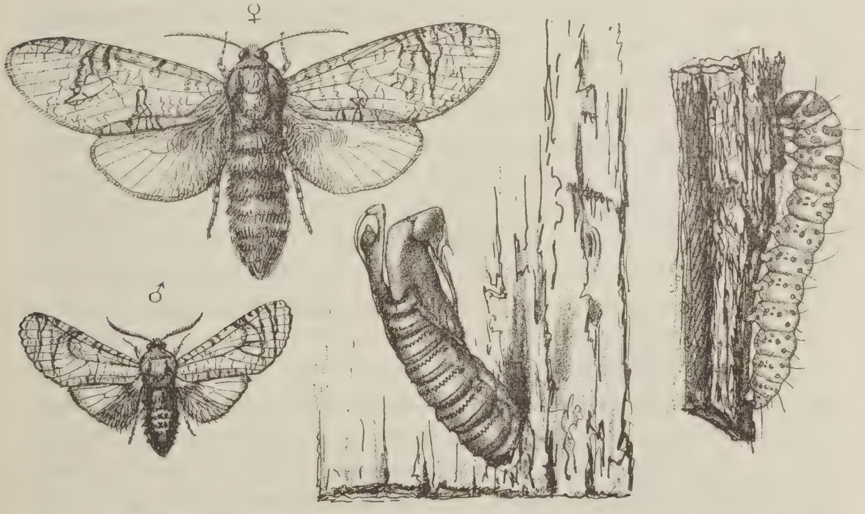

Fig. 50.—*Prionoxystus querciperda* Fitch. Male and female moth, young caterpillar and empty pupal case. Original.

were still small and unfolded. As such virgin females can be well utilized to attract the corresponding males the moth was left upon the black oak tree in which it had spent its early life. Returning at 1 p. m., the female had disappeared, but a close search revealed her, and a male, higher up in the tree. The male, which tried to escape, was captured, and the female was put under a sieve to attract, if possible, other males. This proved useless. At 3 p. m,, the female commenced to deposit eggs, and next morning it was found that 713 eggs had been laid. These eggs, large for the size of the moth, were glued to the inside of the sieve;some were glued to the wire,and being of an almost semi-liquid consistency when fresh, had flowed partly around the wires, so that they could not be removed when dry. Three days later the eggs hatched, and the little caterpillars entered a piece of soft dead wood, which happened to be inclosed for another purpose. This piece of wood was perforated in all directions by the active worms. It was tied to an isolated tree that had to be removed before long as being in the road. The further history of these caterpillars can not be given as the tree was cut down soon afterwards. The caterpillars of this insect are much more active than borers of this kind usually are, and many times half-grown specimens were found running about the ground in places many rods away from suitable trees. The short time required to deposit such a number of eggs, and the rapid development of the young caterpillars in them is very remarkable. It shows that we can not depend very much upon the good offices of such birds as wood-peckers and creepers, since the eggs hatch so very soon after being deposited; besides the female moths possess long and flexible ovipositors by means of which the eggs can be pushed beneath projecting loose bark and into deep cracks.

These large lepidopterous borers, producing night-flying moths, are attracted to the electric light, and in cities where this is used large numbers of these moths are killed.

Fig. 51, Plate 5, shows still another clear-winged moth, the history of which seems to be still unknown. It was captured late in May near the school of agriculture.

THE LEAF-ROLLER ON BOX-ELDER.

(*Cacœcia semiferana* Walk.)

During the middle of June, many of the box-elders along the Interurban Electric Railroad in St. Paul were seen to be suffering from the attacks of an insect which had, in some instances, nearly stripped the trees of their foliage. A closer examination showed the culprit to be a small green caterpillar, which formed a cool and airy nest for itself by bringing together the two sides of a leaf and then fastening the edges together with silk, (Fig. 52, Plate 9). Inside this swinging cradle the caterpillar lived, reaching out and eating the leaf from which its habitation was constructed, so that this cradle furnished both shelter and food. Whenever disturbed, the caterpillars drop from their dwelling places and, spinning a long thread, remain suspended by it in mid-air. When the danger is passed, the caterpillar re-ascends this thread sailor-fashion, hand-over-hand. The leaf-rollers were so numerous that the trees suffered very greatly and were, in some instances, in danger of being killed. Figure 53, Plate 10, shows one tree which was badly infested and nearly defoliated, a second one very much injured and one nearly free from the pest. The caterpillar causing this injury is a pretty, innocent appearing green fellow, about three-fourths of an inch in length. Its color is a very delicate apple-green, with a darker green stripe down its back. The mandibles and minute eye-spots are black. Many specimens were collected with their leafy dwellings and placed in a breeding-cage to rear the adults and whatever parasites might be present.

On June 25, many of the larvæ had entered the pupal stage. Remaining in the rolled leaf, they shed their skins and became pupæ (Fig. 52, Plate 9). In this stage they are somewhat lighter in color than the caterpillars. On each of the first two abdominal segments there is a dark-brown, transverse oblong spot. Each of the succeeding segments, except the last two, has a fine, transverse line. At about this time the adult moths commence to emerge. The pupal skin is usually left partly protruding from the fold in the leaf, the illustration showing the rent down the back through which the moth emerged.

The parents of these leaf-rolling caterpillars are moths belonging to the family Tortricidæ. They are from three-fourths of an inch to one inch in breadth when the wings are fully expanded. The fore wings are of a brownish-yellow color with lighter markings (Fig. 52, a, Plate 9). These markings vary a great deal in different individuals, being entirely absent in some. The illustration shows several detached wings with different types of markings. The hind wings are of a light yellow color with a slightly darker margin. These pretty moths rest on the bark of the trees, and when disturbed, fly for a short distance with a very irregular flight, usually alighting on a blade of grass from which they are readily captured.

Shortly after this time, on June 28, some of the eggs were found (Fig. 52, d, Plate 11). They are always deposited in clusters of from thirty to forty on the rougher bark of the tree, and not upon smooth twigs. The small sack-shaped eggs are set on end, so closely packed together as to cause most of them to become nearly square, when viewed from the end. These eggs being placed compactly and closely together, like so many sacks of grain set on end, are covered with a curious protection made of scales from the moth, which closely resembles the shingles of a house, and which forms a perfectly water-tight covering. The abdomen of the female moth carries on its under surface a thick, broad brush of slender scales, longer and stouter than those covering the remainder of the body. After depositing the sticky eggs she presses the abdomen, while the head is directed downward, against the cluster of eggs. The scales adhere to the viscid covering of the eggs and are pulled out when she draws away her body. The viscid substance is impervious to water. The scales forming this shingle-roof over the egg-mass are lengthwise in position but in reverse order from that which they occupied on the body of the female. They are always directed downward and are closely and evenly laid, preserving the segmentation of the body as shown by the figure. Many of the egg-clusters were collected and placed in cages that their development might be studied, but none hatched this year. They will probably hatch during the spring of 1896. It is, however, possible that an earlier brood had already infested the trees before the insects were discovered; this, however, is not probable. Many of the branches, and even the bodies of some trees, were completely covered with a fine coat of silk, spun by the larvæ in traveling over the tree. Before the middle of July, the moths had all disappeared and soon after this the trees produced new foliage.

A wild cherry tree, close to an infested box-elder, was seen to have some of its leaves rolled, and they contained pupal skins identical with those on the box-elder. It seems that other plants are also to the taste of this leaf-roller, and oaks, hickories and all kinds of fruit trees do not escape. In one case, currants were growing under a tree infested with these caterpillars. Many of them, dropping upon the currants below, went to work and folded their leaves as well, and in time destroyed their foliage.

Parasites. A number of small Hymenoptera are parasitic upon this moth. Plate 9 gives figures of several of these parasites bred from the larvæ and pupæ. At least one-half of the pupæ, collected and placed in cages, proved to be parasitized. It is quite likely that these parasites would multiply to such an extent as to exterminate the moths, were it not for the fact that the moth passes the winter in the egg-stage, thus affording no good wintering-place for its parasites. This unfortunate circumstance makes it necessary for the parasites to find other insects in which to hibernate, and as such suitable insects are not likely to increase in the same proportion as the leaf-roller, many of the parasites must fail to survive the cold season. This of course seriously interferes with the destruction of these reaf-rollers by their natural enemies.

The following species of parasites, respectively lettered *e*, *f*, *g*, and *h*, were bred from the leaf-roller: *Pimpla inquisitor* Say., Fig. 52,e; *Chalcis flavipes* Ash., Fig. 52,f; *Dibrachys* (*Semiotellus*) *clisiocampæ* Fitch., Fig. 52, g; and *Cirrospilus flavicinctus* Riley, Fig. 52, h. Besides these a small Tachina-fly was bred from a larva.

Artificial Remedies. A thorough spraying with Paris-green or London-purple just before the caterpillars commence their operations, would kill the great majority and thus effectually check the evil. This should be done before the leaf-folding process is very far advanced, for after the larvæ are once inside of their houses they are somewhat protected. Still as the caterpillars use their houses both for shelter and for food, a thorough coating with one of the above substances will kill them. If one application is not sufficient, another should be made about a week or ten days later. The first one might be made in the proportion of one pound of the poison to 160 gallons of water, the second in the proportion of one pound to 200 gallons of water. As the caterpillars are not very great travelers, the evil does not spread rapidly, until the moths emerge. They are, of course, able to fly and to start new colonies in distant places. Another remedy is to cover up the eggs or surround them so that the young larvæ just hatched will be unable to reach the leaves. This may be done with a thick wash of lime on the trunk and larger limbs. The eggs are so well protected by the overlapping scales that any penetrating oil as kerosene would probably be useless.

Concerted action is necessary to save our fine shade trees, and as the owners of a few trees can not be expected to possess machines to apply remedies, the city authorities, perhaps the Park Commission, should take this work in charge by appointing some capable person or persons to carry out their instructions.

APPLE-TREE LEAF-FOLDER.

(*Cacœcia rosaceana* Harr.)

Apples and roses are also very frequently infested with a leaf-rolling caterpillar belonging to the family of Tortricidæ. In some seasons the Russian apples are injured to such an extent as to lose all their leaves, and are forced to do two years labor in one, which is of course very weakening to these plants. Roses that are not constantly watched will soon lose most of their leaves by such insects. Early and repeated applications of Paris-green or London-purple would prevent all these damages.

THE SWEET-CORN MOTH OR TASSEL-WORM.

(*Heliothis armiger* Hbn.)

During the latter part of the summer of 1895 many reports were received in which complaints were made about caterpillars found inside the husks of corn, chiefly of sweet corn. These caterpillars feasted upon the young kernels still in their milky stage, and by devouring them formed irregular tunnels and cavities, most frequently near the top, though sometimes the greater portion of the ear was destroyed. Such cavities, filled with the nasty pellets of excrement, were frequently invaded by various moulds, which, in combination with the worm, of course spoiled the ear of corn for any culinary purpose. As a general rule only one worm is found in the ear, and only in cases where the tunnels are entirely separated from each other, two worms may occur. The tassel-worms, like so many of the true cut worms, are decided cannibals, and whenever an opportunity offers they seem to prefer animal food to their normal diet of plants. This voracious appetite was shown whenever a number of such caterpillars were mailed to this office in the same box for identification. Even if the mailing box had been supplied with their appropriate food, only the strongest caterpillars arrived in a more or less battered condition, showing that a battle had been going on during the trip, and all the weaker prisoners had been devoured, as could be seen by the heads and empty skins, which remained to tell the murderous tale.

These tassel-worms are not usually very common in Minnesota, and are met with only occasionally and in certain seasons and localities. Evidently the last season formed an exception, and these caterpillars appeared in large and destructive numbers in many parts of the state. This insect is a cosmopolitan, being more or less commonly found in many parts of the five continents. As is usually the case, we find that like most other insects which exist in such different regions, it is also a very general feeder, thriving upon such plants as corn, cotton, tomatoes, pumpkins, tobacco, beans, peas and many other cultivated plants; a large number of different kinds of flowers and weeds are also to its taste. Although in the southern states a decidedly injurious insect to corn, it is much more so to the cotton, and is much feared in the cotton fields, where it has received the appropriate name of "Boll-worm", since it is in the habit of destroying the young cotton bolls.

LIFE HISTORY.

The parent of this caterpillar is a moth, very variable in color, as might be expected from an insect which feeds upon such a large variety of food plants; usually, however, it is of a pale clay color, or of a dull ochreous-yellow to olive-green, with variable pale olive or dark-rufous markings on the fore wings. The whitish hind wings do not vary so much, having always a broad blackish band, suffused with pink, at the margin, and being usually much paler than the fore wings. The illustration (Fig. 54, Plate 11) shows the normal form of this moth, which expands a little more than an inch and a half. The moths have been caught on the wing in Minnesota early in October, while others were caught on baited trees on October 20. None were caught early in the season, but a related species was found flying on June 1. Early in October the moths are not unfrequently caught at the electric lights. Though generally nocturnal in their habits these moths fly also during the day. It seems that this insect does not winter in Minnesota, but that all are killed late in the fall. This would mean that the insect has to be re-introduced every summer from the more southern states, where it can successfully hibernate.

After mating, the female deposits her beautiful eggs upon the various food-plants mentioned before. These eggs are nearly white, inclined to yellowish, and are about seven millimeters in diameter; their surface is sculptured, having polar ribs with cross furrows. A dissection of the ovaries shows that the female can deposit about five hundred eggs. If the female selects corn she deposits her egg upon the stalk or leaves, preferring the under side of the latter. These eggs soon hatch (in three to five days), and the young caterpillars, which possess a somewhat roving disposition, move about from leaf to leaf, until they find food to their taste. As a general rule they detect the tassels of the plant, or later the tender kernels inside the husks, which they enter, and where they enjoy life by rioting in the tender food surrounding them. I am not prepared at the present time to state how many broods may occur in our state; the worms found under the husk are usually all of about the same size, which would indicate but one annual brood.

The caterpillars vary greatly in color and markings, yet they are most commonly pale-green with longitudinal white or greyish stripes. A common form has the following markings: on each side a broad lateral whitish stripe; above this a narrow dusky one, and upon the back another narrow dusky stripe including a fine white line. Very constant are the eight black spots or tubercles upon each abdominal segment; four of them are upon the back and four upon the sides. On the second and third thoracic joints these setigerous spots are arranged in a single transverse row. Some of these caterpillars are almost immaculate. They measure, when fully grown, a little more than one inch and a quarter. When mature they leave the corn-cob by a circular hole in the husk, and descend to the ground to pupate. Here they form an oval earthen cocoon held together by a few silken threads. Inside these cells they change to a light mahogany-brown pupa, the last segment of which is equipped at the apex with two long and slender spines, very characteristic of this species. The pupa measures seven-tenths of an inch. An illustration is given in fig. 54, on plate 11, of moth, (the upper one), larva and empty pupal skin.

ENEMIES.

These disgusting worms, though so well hidden by the husks of corn or inside the cotton boll, do not escape such insects as usually prey upon caterpillars. Very often the great friend of farmers, the Tachina-fly, utilizes these fat caterpillars as a living cradle for its own young, and the caterpillar, instead of producing a moth, is the home of a number of maggots, which transform into large flies, larger than the common house-fly, and these make it their business to search for other caterpillars in which to raise their offspring. The Tachina-fly, having discovered a caterpillar, buzzes around the same until it succeeds in fastening an oval china-like egg near the head of the victim, from which soon after a maggot issues, which enters the host.

The caterpillar seems to know all about its enemy, and squirms about in a most lively fashion to drive it away, but in vain. The maggot or maggots, once inside the body of their host, feed at first upon the fatty tissues stored up for future use, and do not attack the vital organs until nearly mature. When this stage is reached the maggots force their way out of the dying caterpillar, drop to the ground, enter the same, and contract to reddish brown barrel-like objects, inside of which the true pupa is formed. Soon afterwards a new generation of Tachina-flies is ready to again assist the farmer.

Other parasites, no doubt, also help us to keep the tassel-worms in check. Cannibal insects, such as the beneficial lady-bugs, also eat large numbers of the eggs of the moth, and some true bugs, as the spined soldier-bugs, kill many caterpillars while they move about to enter the cob or when they leave. Turkeys and chickens, if they have the run of the corn-fields, are also very beneficial and should be permitted to range in fields known to be infested with insects of this kind. Our numerous shrews also do good service against such insects and should not be killed, simply because they look like mice.

REMEDIES.

Every caterpillar that is found in an ear of corn when preparing it for the table should be killed and not simply thrown with the leaves forming the husk upon the rubbish heap, as in such a case they will simply crawl to some other plant. Many remedies have been proposed but none seem to be of much value for this insect. A systematic rotation of crops is claimed to keep them in check. Late plowing is also considered a good remedy, as the pupæ hidden in the soil are exposed to the inclemencies of winter. Simple freezing, however, causes but little injury to any hibernating insects, and only repeated freezing and thawing is destructive to them. Such remedies may be of great value in the southern states, but as the moths issue here in October, it is more than doubtful whether any pupæ hibernate at all in our state. It is very likely that all tassel-worms, whether they are larvæ, pupæ or moths, die in early winter, and that the worms found during the month of September in the ears of corn are produced from moths which immigrated north from the southern states in which they always occur.

THE ROSIN WEED CATERPILLAR.

(*Heliothis phlogophagus* G. & R.)

Another species of Heliothis was, a few years ago, very common near the Experiment Station, but instead of causing injury, it assisted us very materially to check a bad weed. The rosin-weed (*Grindelia squarosa* Dunal) is a western plant, which had found a lodgement along the railroad tracks and near by. Here it rapidly increased, and would have scattered far and near if unexpected assistance had not arrived. The plants grew very vigorously and produced immense numbers of beautiful golden flowers; they also produced lots of seeds, but before these seeds ripened it was found that every head normally containing them had been eaten into and emptied of them. This good work was performed by the caterpillars of the above moth. They were so thoroughly well protected by their color and position that it was almost impossible to detect them, and only by beating the plants could they be obtained in large numbers. Those caterpillars that rested upon the greener portion of the plant possessed a corresponding green color, while those that rested upon the browner parts were brown. They were also much more spotted and almost spiny, so that they blended well with the spiny appearance of this composite plant. Like the tassel-worm they entered the ground and appeared as moths between Oct. 10 and 15. The moth resembles that of the tassel-worm, but has darker markings. This species was also found flying during a bright sunny afternoon on June 1. Since the disappearance of the rosin-weed the insect has not been found again. The moth is illustrated in Fig. 54, Plate 11 (the darker one).

The above case is an instance where an injurious insect may become beneficial, and a number of other cases were discovered here, where otherwise injurious insects became our friends. The native cabbage-butterfly, which is decidedly a noxious insect, utilized the Russian thistle as a food plant, and immense numbers of their caterpillars could be found upon this dangerous weed.

An european weed, which has recently found its way to our state, the stork-bill (*Erodium cicutarium* S. Her.), has been almost entirely killed off by the caterpillar of a nocturnal insect (*Pyrrhia angulata* Grt.) which is, however, the european *Pyrrhia umbra* of Hbn.

Our common bull-thistle, which at one time almost entirely covered some waste places near the farm, has almost disappeared. This was owing to the good work of a small moth belonging to the family of *Pterophoridæ.* Many other cases could be given, where noxious insects have done good by eating weeds.

THE PARSLEY BUTTERFLY.

(*Papilio asterias* Fabr.)

Among the many beautiful butterflies none are perhaps better known than the swallow-tails. Some of them, as far as beauty is concerned, well deserve the poetical name of "winged flowers." Swallow-tails contain the largest butterflies found in Minnesota, and there are few people who have not admired their graceful and stately flight. All these butterflies are themselves perfectly harmless, as they sip only the sweet nectar from the flowers, and as they fly from flower to flower they are important agents in cross-fertilizing them. Of the three species of swallow-tails found in Minnesota only one is common in our gardens, but this one causes more or less injury to nearly all plants belonging to the family of umbeliferæ. This swallow-tail butterfly is distinguished from the two other kinds by its black color. The sexes differ greatly. The male is distinguished by having two bands of sulphur-yellow crossing the wings as shown in the illustration, Fig. 55, Plate 12. Between these yellow bands of the hind wings are a number of faint spots of steel-blue color. At the inner angle of the hind wings is an eye spot surrounded by red. The abdomen of the male, like that of the female, is spotted with two rows of yellow spots on each side. The female has rows of smaller spots on the wings, but the steel-blue spots on the hind wings are very much larger than in the male. The under side of both sexes is similar and is distinguished from the upper side by having rows of orange instead of yellow spots. The illustration shows the markings much better than a description.

The first brood, or spring brood, of the parsley butterfly issues about the time that the carrot-leaves appear above the ground. The butterflies, after chasing each other for sometime, and showing their beauty by fully expanding their wings while resting upon the foliage, mate, and soon afterward the female is busily engaged in searching for the proper food for her progeny. At this time the leaves of the carrots, dill and some wild species of umbelliferous plants are selected. Gracefully resting upon a leaf she bends the abdomen in such a way as to glue a single egg upon or below the leaf near its tip. After a short flight another egg is fastened to another plant, and in this manner a large number are deposited during the few weeks that the insect flies about. Most of the eggs are fastened to the ribs of the leaves, and only occasionally upon the leaf itself.

The beautiful eggs, covered with fine granulations, are first of a honey-yellow color, which later changes to a reddish-brown. In about eight days a little caterpillar hatches from this egg. It is very black with a white band across the middle. It feeds voraciously, sometimes doubling its length in one day, and attaining ten times its former bulk. After throwing off its old skin a number of times, it reaches its full size, when it is about one and three-fourths of an inch in length. The caterpillar now possesses a pea-green color, with a transverse black band on each segment. In each of these black bands are four bright yellow spots, two on each side. The greenish head is also striped with black. This rather striking caterpillar does not hide like so many other caterpillars, but lives fully exposed upon its food plant. It possesses two horn-like organs, of a pale orange color, which are usually not visible, being withdrawn into the first thoracic joints When disturbed, these organs are extended in a threatening manner, or if the caterpillar is roughly handled they are projected to their fullest extent like two whips. They now emit a strong and unpleasant odor, somewhat like the bruised leaves of their food-plants. These organs are used to drive away parasitic insects, which try to fasten their eggs upon the caterpillar, and thus use it as a living cradle for their own offspring. Yet notwithstanding these defensive organs, parasites frequently succeed in their purpose.

When the time arrives to transform into a chrysalis the caterpillar searches for a suitable spot and prepares for pupation by spinning a small silken carpet, to which the posterior end of the body is fastened, and it also forms a loose loop of silk around itself, so as to be more secure when the larval skin is exchanged for the pupal one. The pupa is brownish, and resembles a piece of wood so thoroughly as not to be readily detected. Soon afterwards the butterflies appear and produce a second generation. The insect winters as a chrysalis.

The caterpillars are voracious feeders, and when numerous can cause considerable damage to such plants as parsnips, fennel, dill, caraway, celery, parsley, anise, carrot and most wild species of umbelliferous plants.

REMEDIES.

As the caterpillars live exposed upon the plants they select for food, and as they are so very voracious, their presence is readily detected, and the remedies as easily applied. A thorough spraying with Paris-green or London-purple in the usual proportions will soon reduce their numbers, and there is no excuse to permit these insects to appear in destructive numbers.

THE BOX-ELDER BUG.

(*Leptocorisa trivittata* Say.)

There are few insects that have created such a sensation, such a fear, as has the above bug during the last two years in Minnesota. Early in September, and all through October and the early part of November, the letter carrier never failed to bring his daily ration of letters asking for information in regard to it. Packages of all kinds arrived at the office of the entomologist and contained almost invariably specimens of this brightly colored insect. Some writers feared that these bugs might be an improved breed, an enlarged edition of the injurious chinch-bugs; others complained by stating that bed-bugs were bad enough, and that they did not care for an addition of domestic insects so much larger than those cultivated before. This fall such inquiries were so numerous that it was deemed best to publish articles about this insect in most of the daily papers and thus to allay to some extent all exaggerated fears. The insect is not as bad as its long scientifie name would indicate; in fact, such long names are only of a threatening aspect to people who have not studied any branch of natural history. It is frequently asserted that the smallest animals have the longest names; this is not so, however, as some larger ones are distinguished by names that are long in proportion to their size. Scientific names are a necessity, though they may appear an evil to some persons.

The box-elder bug, well known in the south by the name "cotton-stainer", has indeed so rapidly increased in numbers in our state that most people claim that they only were recently introduced. This is not the case, however, as they are old settlers, older than any member of the "Early Settlers Association". But they have not forced themselves upon the attention of our citizens until during the last few years. Their rapid increase, or rather the reason that they are at present noticed so much more frequently, is owing to the fact that the box-elder is now grown more commonly along our streets in cities and towns than formerly. Being a very hardy tree, one of the best adapted for villages in the open prairies, they are there most usually selected for shade trees. They form also a large proportion of the trees utilized for wind-breaks and timber claims. Considering this rapid increase in their numbers it is no wonder at all that insects which utilize this tree as food, should also increase very rapidly. This has been the case, and where a few years ago the box elder bug was an unknown insect it is now found in large and increasing numbers. Still this great increase would not be noticed, or only by a few more observing persons, if this insect did not possess the peculiar habit of crowding together late in the fall, preliminary to searching suitable quarters to hibernate. As soon as the foliage of the box-elder becomes dry and discolored, or, in other words, as soon as the leaves of the tree no longer offer liquid sap to the insects, these desert such useless sources of liquid food, and descend to the limbs and trunks of the trees. Here they gather in large numbers, perhaps to hold indignation meetings about the shortness of summer and food supplies. At all events they crowd together, old and young, as if waiting for better times. Whenever the sun shines and warms one side of the trunk, or the sidewalk below the tree, there these bugs are sure to congregate. Later, and when the leaves commence to drop, all bugs have reached their full size, all are winged. But they do not use their wings, and are very sensible not to do so, because they assuredly would be blown about the adjoining prairies and perish. These bugs now search for winter quarters. If the sidewalk under the box-elder trees, their old homes, should be a wooden one, most of the bugs find a shelter under it. If no such shelters are found, however, the insects enter barns and stables, and are not slow to enter even houses, much to the disgust of the ladies of the household. The bugs are decidedly stupid; at least they can not be scared away, but have to be forcibly ejected. This habit of crowding into dwellings has been the cause of many complaints.

The life-history of this box-elder bug is told in a few words: here in Minnesota it infests only the box-elder, not having as yet been found injurious to other trees. The bugs, being sucking insects, insert the organs of suction, which are inclosed in their beaks, into the tissue of the leaves, always choosing their underside. Here they live in plenty, undergoing all their changes from a young larva to the adult insect, until the supply of liquid sap flows more and more slowly, when they are forced to leave, as has already been mentioned. Frequently eggs are found early in the spring upon all sorts of things stored away in our out-houses. This should not cause such a fear as was expressed in a letter, in which the writer asked whether the insects resulting from such eggs would injure his new selfbinder, as that machine had been covered with eggs. Most of the young bugs hatched from eggs deposited in such situations will die before reaching a suitable tree.

To kill these bugs is not an easy matter, as they can not be poisoned like insects with a biting or chewing mouth. To kill them at all would require a powerful spraying machine, by means of which the entire tree could be thoroughly sprayed. Such a machine is not found in the possession of people having only a dozen or so of shade-trees in front of their houses, nor could we expect this. But as the cities and villages are interested in good and healthy shade-trees in their streets and parks, the authorities should buy sufficient good spraying outfits, and should engage men to use them frequently and intelligently, not alone against the box-elder bug, however, but against all insects infesting our shade-trees. During the warmer parts of the season most of the shade-trees are in a decidedly bad condition, owing to all sorts of insects, but chiefly to leaf-lice of various kinds. A forcible spraying, even with pure water alone, would be a wonderful blessing to such dusty and bug infested trees, while repeated spraying with kerosene-emulsion would soon transform these neglected and unsightly trees into things of joy and beauty. Under the head of leaf-lice formulas are given for kerosene emulsion. Farmers possessing wind-breaks should all possess spraying machines, which are discussed in another place.

The box-elder bugs have one peculiar habit that we can utilize to keep them from becoming too numerous. They crowd together during the autumn, and are very slow and apparently stupid during the colder parts of the day. As they gather together in large numbers, such meetings could be enlivened by the owners of the trees injured by these insects, by pouring some boiling hot water over their enemies. This would dispose of many. Other meetings could be broken up by sweeping the bugs into tin pans or directly into a fire. The free use of kerosene oil upon the bugs upon side-walks or other places is also a good way of reducing their numbers; of course the oil should in no case be thrown upon the trunks of trees for that would be apt to kill them. In fact the bugs should be killed whenever and wherever seen, since otherwise they will increase still more, and to the great injury to the box-elder.

The illustration (Fig. 57, Plate 13,) shows this insect in its different stages; the adult, shown both enlarged and in natural size, is a bright-colored insect. All the parts shown black in the illustration are of that color in the insect, while the light-colored parts are a bright red. In other words this bright color forms three broad lines over the black thorax, whence the latin name *trivittatus* or three-banded. The harder parts of the wings are edged with red, and all the veins are of the same, but more dingy color. The earlier stages of this insect are distinguished by the same color, which, being even brighter red than in the adult insect, enables us to readily detect them.

THE BEAN-FLY.

(*Anthomyia spec.*)

During June many letters were received from various parts of the state complaining about injuries to beans. The following letters may serve as examples:

PROF. O. LUGGER, St. Anthony Park, Minn. Dear Sir:—I send you by to-day's mail a package containing a baking powder can, in which you will find some young bean stalks. If you will examine these stalks you will find them tunnelled by a small worm or grub, which attacks the sprout before it comes up. Some of the sprouts inclosed were not yet above ground, but are completely hollowed out. It is something entirely new, but the attack is very severe in this section. Whole fields of beans, in many places containing many acres, are completely ruined, and are being plowed up.

Can you tell us what it is, and whether there is any remedy?

Also, is there any remedy for cut-worms, other than hunting down each specimen? Respectfully,

Park Rapids, Minn., June 21, 1895. ENOS M. RICKER.

PROF. OTTO LUGGER, State Experiment Farm. Dear Sir:—Some beans were planted on my farm one-half mile west of Wadena on ground that had been newly plowed and had previously been coated with barnyard manure. The seed was old, and some of it had been picked after the frost came. After about ten days, seeing that they did not come up, I dug into the hills and found that the beans were gone. After opening several hills I succeeded in finding the specimens enclosed. Is the worm a product of the soil, or did it develop in the bean? If the former, what means can be used to destroy it? Respectfully,

Wadena, Minn., June 24, 1895. H. W. FULLER.

It seems that about one-third of the state was more or less infested with this new enemy, but chiefly the more northern counties. Here it did great damage, in some cases destroying nearly all the bean-plants, while in others farmers were forced to re-seed their fields. The work of the insect is shown in Fig. 58, Plate 14. It will be noticed that not only the seed is hollowed out, but the stem as well, thus invariably killing the plant. The worms that cause this damage are footless maggots, measuring about a quarter of an inch or a little more; they are of a yellowish-white color, tapering in front and blunt behind, as shown in the illustration. After feeding some time inside the bean or bean-stalk they reach their full size, and leaving the old home they penetrate into the surrounding earth, where they contract into peculiar barrel-shaped, smooth, light yellowish-brown puparia or false pupæ. Inside these puparia, which are nothing but the shrunken old skins, the true pupæ are formed. In about a week after having changed to a puparium, the adult insect pushes open a little cap at the front end of the puparium, and works its way to the surface. The adult insect is a small fly illustrated in Fig. 58, Plate 14, both enlarged and natural size. It resembles a small house-fly, and lacks all conspicuous markings. Soon after appearing as flies those kept in captivity with young and growing beans deposited a few elongated, white and glistening eggs, which, however, were not fertilized. This at least was the conclusion arrived at, as no maggots appeared in the beans or stalks of beans growing in the breeding-cage. Nor could any worms be found later in fields seeded a second time with beans, which seems to indicate that the other generations produced by these insects during the summer possess different habits than the first generation. This is also borne out by many other observations.

The flies belong to the genus of *Anthomyia*, a genus of flies in which the larvæ have very different habits, although the adults resemble each other very closely. Some of these larvæ live inside the soft kernels of seed-corn; others attack onions, radishes and stems of cabbages; others again breed in decaying vegetable matter and dung; some produce mines in various leaves, and still others become our friends by eating the eggs of grasshoppers. The flies resembling each other so closely it was thought best not to add another name, very likely a synonym, to the already long list of such worthless names.

It is possible that owing to the unusual wet season at the time that these beans sprouted and grew, these flies left their usual food, decaying matter, and attacked the richer one planted for them. Flies of this kind are always numerous in Minnesota, and they frequently swarm in very large numbers.

Remedies.

It would be very pleasant to give some real good remedies against this insect, which may appear again, though very likely this will not be the case for a number of seasons. As a general rule the mischief is all done before the culprit is discovered, and a remedy under such conditions is out of the question. Toward the close of June no more damage was caused by these maggots. The following letter, one of many received, indicates this very well:

> PROF. OTTO LUGGER. Dear Sir:—Since sending you the sample of infested beans have lost 25 per cent of the crop, but now can not find many stalks, so shall replant at once.———————— Since writing you before have heard of a neighbor that lost his crop in the same way; have also examined several fields but can not find any maggots.
>
> Yours respectfully,
>
> Alexandria, June 29, 1895. J. W. ROBARDS.

Late planting, or planting after the spring rains are over, would very likely prevent a repetition of the trouble. On a small scale hot water could be used; this remedy has been found a very good one against the related, or identical, maggots that injure onions and corn. Of course where a big field is concerned, such a remedy would be impossible to apply. The coating of the seed-bean with gas-tar, blue-stone or copperas has been tried on a small scale, and has been found to protect the plant, though delaying the sprouting for some time.

THE WHEAT-STEM MAGGOT.

(*Meromyza americana* Fitch.)

During the time that wheat was filling it was noticed that many heads, instead of filling normally, gradually turned white. Such white heads, contrasting so strongly with the vivid green of the others, attracted the attention of many farmers and consequently a large number of inquiries in regard to this "new trouble" reached this office. In investigating the straws received it was found that invariably only the upper part of the plant, above the last joint, was dead. This is well shown in the illustration (Fig. 59, Plate 15). Cutting open this injured stem it was found that the interior of it had been more or less destroyed, and that the injury was caused by a maggot, which by its presence and work prevented the sap from rising, thus cutting off the supply that nature intended to change into gluten and starch. Such "bald heads" were by no means uncommon, and in some places amounted to fully 5 per cent of the plants, in extreme cases even one-tenth of the whole crop was ruined in this manner. Very few farmers had ever noticed such "bald heads" before, and were consequently quite worried about this new wheat pest.

The wheat-stem maggot is by no means a newly arrived insect in this country, having been described by Fitch as early as 1855, though other records show that it had already injured wheat in Pennyslvania as early as 1821. Many recent writers have written about this insect and have given careful accounts of its natrual history. It seems that at least three annual broods occur in Ohio and Illinois, as proved by Profs. Webster and Forbes, and that still further south even more may be produced. But these excellent accounts of the life-history of this fly throw but little light upon its history in Minnesota, at least in that portion where only spring wheat is grown. And it was in those parts of the state that the maggots were so common last summer, having been found from the Red River Valley to the central part of eastern Minnesota. They were also common on the Experiment Farm. According to the accounts given by the above named entomologists, the flies found in the wheat fields in September and October deposit their eggs upon the young plants of winter wheat; the young maggots make their way downwards, feeding upon the central part of the stem near the surface of the ground, and cutting this off entirely, cause it to die. In these positions the maggots hibernate, appearing again as adults in spring. These flies of the first brood again deposit eggs, the maggots of which in time destroy the stems just above the upper joints. After killing this upper part of the plants, another brood of flies, the second generation, appears, which emerge in July and deposit eggs in volunteer wheat or grass. From these maggots a third brood is produced, which develop into flies the same autumn, and deposit eggs upon the young plants of winter wheat. How many broods of this insect may be produced in Minnesota is not known. Only one thing is certain and that is that their life-history must be quite different in a region where volunteer wheat is a very uncommon thing, and where winter wheat is never grown. It is true we have in such regions a number of grasses that might possibly give this insect a shelter, as it is known to attack elsewhere, besides wheat, such grasses as wild-rye, blue-stem, Poa and even green pigeon grass. Perhaps this may be the case, though none of the wheat-stem maggots have thus far been found here in such grasses. Here at the Experiment Station the flies issued from material kept in breeding cages from July 22 till Aug. 4.

The illustration shows three straws of wheat infested by the maggot. It shows also the pupa resting inside an open stem, and the injury caused by the maggot. A fly, natural size, is resting upon one of the straws. Larva, pupa and adult, greatly enlarged, are also shown. From many of the stems, instead of flies, parasites issued, showing that notwithstanding the hidden life led by these maggots, their enemies can find them. This parasite (Fig. 59, Plate 15) is a wasp, and is also shown upon the plate, greatly enlarged; its natural size is indicated by the lines near it.

The adult flies, about $\frac{1}{18}$ of an inch long, are of a pale yellowish-green color. The large head is marked with a triangular black spot at base, inside of which are located the three simple eyes; the large compound eyes possess in life a beautiful bronze color. The thorax is marked with three longitudinal bands; the abdomen is also ornamented with three longitudinal bands, which are interrupted at the sutures, but more or less confluent toward the posterior end. The color of the underside of the fly is uniformly yellowish-green, excepting two triangular spots upon each side above the posterior and middle coxæ. The legs partake of the same general color; the thighs are slightly darker, and the tibiæ and tarsi dusky. The hind pair of thighs are very much swollen, and are provided on the under surface with two rows of small spines. The hind tibiæ are very strongly curved. The two large basal joints of the antennæ are yellowish.

The eggs of the American Meromyza are glistening white, with longitudinal ridges, the space between the ridges is faintly reticulated. They are very elongated, being .023 of an inch long and .005 of an inch broad.

The larva or maggot is very pale green and very slender, being about one-fourth of an inch long by one thirty-second of an inch wide. Its head is provided with a pair of black toothed hooks. The covering of the apparent pupa is simply the shrunken larval skin, which protects the true pupa forming inside. As soon as the real pupa is formed it becomes visible through the transparent larval skin, and is seen to be also of a pale green color. It is about one-sixth of an inch long and about one-thirtieth of an inch broad. As the imago is formed inside the pupa, the eyes, wing-pads and legs become apparent.

Some of the adult flies were sent to Prof. F. M. Webster for comparison. He says: "I am a good deal puzzled. The flies do not look exactly alike (like Ohio specimens), yet do not vary more than we might expect, considering distance and latitude that have separated Minnesota specimens from eastern ones. The method of attack by the larvæ is exactly the same, i. e., eating off the green straw just above the upper joint. I could see no striking difference in the appearance of the puparium, but yours was outside of the stem and underneath the sheath. (Evidently this was an exceptional case). I believe our insect always pupates in the stem among the frass and refuse left by the larvæ. That these flies are closely allied if not identical, I am convinced, but I hesitate to say that yours is typical *Meromyza americana*, and Fitch's description does not solve the problem." A careful comparison has convinced me that the insects bred from Minnesota wheat-straw are identical with those bred from more eastern and southern straws, and that the flies vary among themselves to a sufficient extent to account for extreme differences that may occur.

THE HESSIAN FLY.

(*Cecidomyia destructor* Say.)

The history of this destructive fly in more southern regions is briefly as follows: there are ordinarily two broods which appear during May and June, and later during September and October. The fly is a small two-winged insect, dusky in color, and about one-eight of an inch in length (Fig. 60). The male is very slender, and the female, when ready to deposit her eggs, a little stouter. The eggs, oval and bluntly pointed at each end, are about one-fiftieth of an inch long, and of a dull

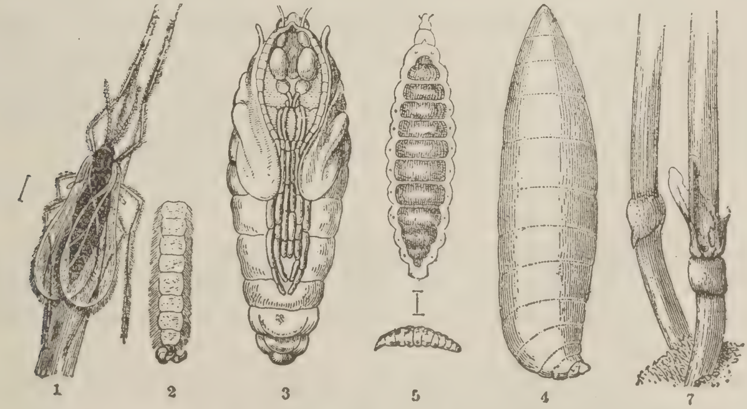

Fig. 60. Hessian Fly. 1. Adult female; 2, Male abdomen; 3 Pupa removed from "Flax-seed"; 4, 5 Larva; 7, "Flax-seed" in position.

reddish color. They are laid singly, or two or three in a cluster, on the upper side of the leaf. The young, a small white maggot, as soon as hatched, works its way downward inside the sheaths to feed on the succulent tissue at the base of the stalk. In the fall they usually go beneath the surface of the soil, but in the spring more often stop just above the surface at or near the lower joints. The insects feed there until ready to change to the pupal or flax-seed stage, which is done between the sheath and the straw. The flax-seed stage takes its name from the great resemblance between the puparium and the seed of flax in size, color and form. The little seed-like puparium contains the true pupa, from which issues the future fly at one of the periods mentioned above. The presence of the puparium or flax-seed stage can usually be detected by the breaking down of the stem at the point where it is found. This breaking down is due to the weakening of the stem, having its interior partially eaten away by the maggot. The insect is said to be two brooded in more southern places, but there may be adult individuals found at any time between the two broods, not, however, in very great numbers. Such individuals mature in wheat sown out of season, or else in volunteer wheat.

REMEDIES.

In more southern states the following remedies are of value:

Late sowing of fall wheat.—This furnishes the fall-brood, which issues in September and early October, nothing upon which to deposit its eggs, or if deposited, it is too late for them to burrow to a safe place in the stem to pass the winter.

Burning the stubbles has been found to destroy many of the maggots and flax-seeds.

Rotation of crops often leaves the adults without wheat plants on which to deposit eggs, so that when wheat is again sown, the flies are all dead in that vicinity. It is a process of starving them out.

Pasturing early sown wheat in the fall is likely to destroy large numbers of maggots and flax-seeds.

The hessian-fly, though not commonly found in Minnesota, has obtained a foot-hold in many parts of the state, and not simply in the southern counties, where both winter and spring wheat is grown, but also in the Red River Valley, where the former variety of wheat is not utilized. It is difficult to understand how this insect can exist under such conditions. If it was a single-brooded species an explanation would be simple. The only feasible remedy in our state consists in burning the stubble, and this should be done throughout the infested regions.

APHIDES OR PLANT-LICE.

If there is any family of insects which is being constantly fought the world over by farmers, nursery-men, gardeners and florists, it is the family of plant-lice. They are all small, the largest measuring not more than a quarter of an inch in length, while the very great majority are very much smaller. The bodies are somewhat pear-shaped, with slender legs and feelers. Wings are only present at certain stages, being usually absent. Near the rear end of the body are two short tubes, which secrete a sweet liquid called honey-dew. This is greedily devoured by ants, which may always be seen in attendance wherever plant-lice are to be found; a sketch, showing an ant in the act of milking its cow, the louse, is given in Fig. 61. The fact that ants protect such lice is sometimes of serious consequence to our farmers, for instance in the case of the grain-louse, where the ants remove a number of the lice to their underground tunnels and protect them during the winter, thus enabling these injurious insects to withstand the severe winter, and to emerge in the spring ready to commence their attacks on the grain.

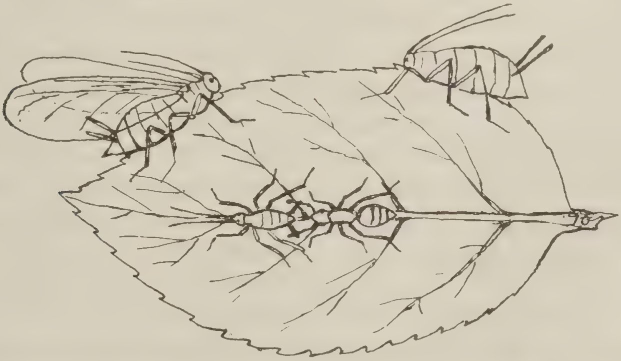

Fig. 61.—Plant-lice, and ant in the act of milking louse. Original.

In the case of most of our native plant-lice, winged forms are produced in the autumn to enable the female to deposit the winter-eggs (Fig. 62, Plate 14), in a suitably protected place. Winged lice seem to spring from the earth just before the leaves fall from the trees, and sometimes they are numerous enough to form clouds. During the summer most species of lice possess no wings, all are females, and reproduce without the intervention of the male. This is carried on for a great many generations, but in the life-history of each species there is a time in which both sexes appear and mate. During the summer lice reproduce by budding, and not in the usual way. Lice that possess wings are not necessarily sexual insects; in many cases such winged insects are simply "nurses", which deposit living young upon trees not so badly infested as the ones they left.

The presence of plant-lice is made manifest in various ways. Sometimes the plant is sapped of its vitality and dies, or is impoverished simply by loss of its sap. At other times an abnormal growth is produced in the leaf or stem on which the louse feeds. In the case of the currant-louse (Fig. 42, Plate 8), as well as in that of the plum-louse, the twisted and bladder-like leaves present a shelter in which the young lice can be raised in safety. At other times again the abnormal growth extends to the formation of a hollow gall, in which the family of lice live very much as in a small house. Our cottonwood trees produce a familiar example in the form of large terminal galls; such galls are always open to allow for the exit of their inmates. Fig. 63, Plate 8, shows a common gall on the elm, called the cockscomb gall from its fancied resemblance to the comb of a fowl. At other times plant-lice work on the roots of plants, as in the case of our lettuce root louse, and the grape-phylloxera. In the latter case large knobs and gall-like swellings are produced by the sucking lice, and here they may be found. The lice, if infesting european grape-vines, usually cause the death of the vine. This same insect, which produces galls on the roots of the vines, can also produce small galls on the under side of the leaves; these leaf-galls are hollow and serve as houses for the lice. The wooly louse of the apples is a species which is becoming more and more important and destructive with the development of our apple orchards. They collect in clusters, which become very conspicuous, because the louse is covered with a white wooly matter. In consequence of their work the bark ceases to grow wherever such clusters occur. This species has also a root-inhabiting form, which, like the phylloxera, causes gall-like growths on the smaller roots. This makes this pest a very difficult one to combat.

The cabbage-aphis (*Aphis brassicæ*) occurs toward the latter part of the season in very large numbers on the cabbage and its near relatives, the rape and rutabaga. They crowd the under surface of the leaves, preferring the younger and more tender ones, and cause a curling of the leaves as well as a general waste of their strength. This little pest is covered with a waxy powder, which repels water, and thus partially protects the plant-louse against such poisons as are applied with water. Kerosene-emulsion will, however, kill them if thoroughly and repeatedly applied.

The aphis that inflicts the most damage to the florist and to the owner of the green-house is known as the green-fly. This delicate little pest is the cause of much labor and expense. It thrives upon most of the plants grown in green-houses, causing them to wilt and grow sickly, and often to die.

The ash-tree is frequently infested with a leaf-louse which attacks its leaves at the ends of branches, and curls them very badly. Immense numbers of lice are produced in such curled leaves, where they are fairly secure from rains. Our box-elders are badly infested with similar insects, which spread over the whole tree. The willows in wind-breaks do not escape, as dark brownish-red lice occur there in immense numbers, which, when crushed, give a dark reddish-purple stain.

Wherever such insects occur in large numbers they are apt to coat all the leaves with the sticky honey-dew mentioned before. This material, if not removed by the attending ants, forms an excellent home for a number of lowly organized plants, and some of them thrive in this soil to such an extent that the leaf—at first simply covered with honey-dew—is soon hidden beneath the black colonies of such plants. We have in Minnesota no worse enemies to shade-trees than such lice, and they increase here with wonderful rapidity, owing to our unusually dry summers. Being often so well protected by the curling of the leaves, caused by them, remedies are not easily applied. It ought to be the office of the park commission to see to it that all treee growing along the streets should be properly attended to. Wherever this is done, as in the city of Washington, D. C., shade-trees are a pleasure and not a disgrace.

Leaf-lice furnish in the honey-dew produced by them considerable honey to our bees. Yet this honey is very poor, and so much like adulterated honey that it finds no ready sale. Moreover it is sometimes the cause of dysentery, when bees are forced to consume it during winter. and early spring, so that apiarists have no special reason to be thankful to the producers of this material.

Remedies.

In dealing with plant-lice we must remember that they are sucking and not biting insects. Their beaks pierce through the layers of Paris-green into the plant, from which they suck the sap without harm. Still an application of this material will kill large numbers, as it seems to irritate their skins and dislodge the insects. In order to fight these lice we must apply some remedy which will kill by contact. When used on a large scale, kerosene-emulsion is undoubtedly the best remedy. The standard formula of Mr. H. G. Hubbard is given below:

Kerosene..................................	2 gallons
Common soap or whale oil soap...........	½℔
Water.......................................	1 gallon

Dissolve the soap by boiling in the water, and after removing from the fire add the kerosene and churn the mixture by means of a force-pump while still hot. Direct the stream from the nozzle back into the mixture for five or ten minutes. The mixture, when perfectly emulsified, acts like thin cream, and should adhere evenly to the side of the vessel without oiliness. It is creamy in consistency and becomes thick on cooling. To use this emulsion mix one part of it with nine or ten parts of water, and apply with a spraying-pump. It requires some trouble to make this emulsion, and in some cases one or the other of the following substances may be substituted in its place.

Whale-oil soap is very useful in gardens, on rose-bushes, or even in the case of some house-plants. A strong solution of this, one pound to a gallon of water, will, if applied with a sprinkler, kill any aphis with which it comes in contact. In case the whole plant can be dipped in a pailful of the solution the result is even more certain. Ordinary soap-suds is of use, although greatly inferior to whale-oil soap; it should be used in the same way.

Tobacco decoction is largely used as a wash and sometimes is very efficacious.

Alcoholic extract of pyrethrum may be used with great effect when only a few plants are to be protected, as in conservatories and among house-plants. This extract is made by soaking 50 grams of buhach or pyrethrum in 200 cc. of 95 per cent alchohol for about a week. It should then be filtered and applied with an atomizer to the plant, after diluting it with an equal amount of water. The dry pyrethrum is useful, although it looses its strength very quickly when exposed to the air.

Fumigation is perhaps the remedy most generally practiced. It consists in allowing the dampened refuse of tobacco, such as stems and fragments of leaves, to smolder in a closed room or some confined place in which are the plants to be fumigated. This can sometimes be done with house-plants by throwing a blanket over the plants, and allowing this to confine the smoke which is generated by the side of the plant. Care must be taken not to fumigate too strongly or too long, as otherwise we may injure the plants.

SCALE-INSECTS OR BARK-LICE.

(*Coccidæ.*)

This group of insects takes its name from the scale or covering with which most of its members are provided. They are nearly all minute insects, the scale rarely measuring more than one eighth of an inch in size, most of them being even smaller. Some of the insects included in this family, on account of the affinity in structure, though unprovided with a scaly covering, grow larger, as the cottony maple scale. The young of these curious scale-insects are small, oval lice, which run about actively for a few hours or days, and during this period may occasionally be carried upon the feet of other insects or birds to distant places, thus starting new colonies in case these latter alight on the proper food-plants. In a short time, the young louse settles down, inserts its beak in the plant and finding there a suitable source of food, commences to grow. Before long, there appears over its body a slight covering of waxy or cottony material, which serves both for protection and concealment. Soon afterward the larva commences to secrete a firm, papery, shield-like covering, which in time becomes the scale proper. During the completion of this scale, the skin is shed once by the male and twice by the female. Both sexes lose their legs and antennæ in shedding the skin, thus becoming mere immoveable sacks capable only of feeding and secreting the scale. The mouth of the louse is provided with a long, slender and thread-like sucking-tube which is thrust into the tissue of the plant, and serves as a sort of hose through which to suck the sap. To secrete the scale, the louse is provided with many spinnerets at the rear end of the body. The arrangement of this spinning apparatus is used to classify the numerous species of bark-lice.

In due time the male molts for the second time and changes to the pupal stage, during which time wings, antennæ, legs and other appendages are formed inside the pupal skin. Before long the male emerges as a delicate, two-winged insect with one or two long and tail-like appendages. As the life of the male is very short no food is required, and consequently the mouth is rudimentary and a second pair of eyes takes its place.

The female bark-louse always remains under the scale. After the union of the two sexes the male soon dies and the female commences to lay eggs, retiring into one end of the scale and gradually shrinking during the process to a mere shriveled skin.

The time when the eggs are laid varies with the species, many laying them during the autumn, but some passing the winter in a partly-grown condition, deposit the eggs in the spring. The forms of the scales vary considerably, most of the species having a characteristic appearance which can be distinguished by the naked eye.

Remedies.

As most of these insects, when old, are provided with waterproof coverings and can not be easily reached by spraying, it is advisable to spray when the young and still unprotected larvæ move about in search of a suitable place to settle, or just after they have settled down and commenced to secrete the scale. The most efficient remedy is found to be kerosene-emulsion in the proportion of about one part of the emulsion to fifteen of water. The infested trees should be most thoroughly sprayed with this emulsion. Another method, but one which is inferior to the emulsion, is to give the tree a thorough drenching with a strong solution of whale-oil-soap. In California the common treatment is to enclose the tree in a moveable tent-like covering and to pass hydrocyanic acid gas into the tent. As this gas is very poisonous, all the insects on the tree are killed. Another remedy used in California is rosin wash. Its use may in time become necessary here, but kerosene-emulsion is preferable where efficient.

Below will be found descriptions of some of the most destructive scale-insects in Minnesota. In Fig. 64 are given the different stages of an insect of this family.

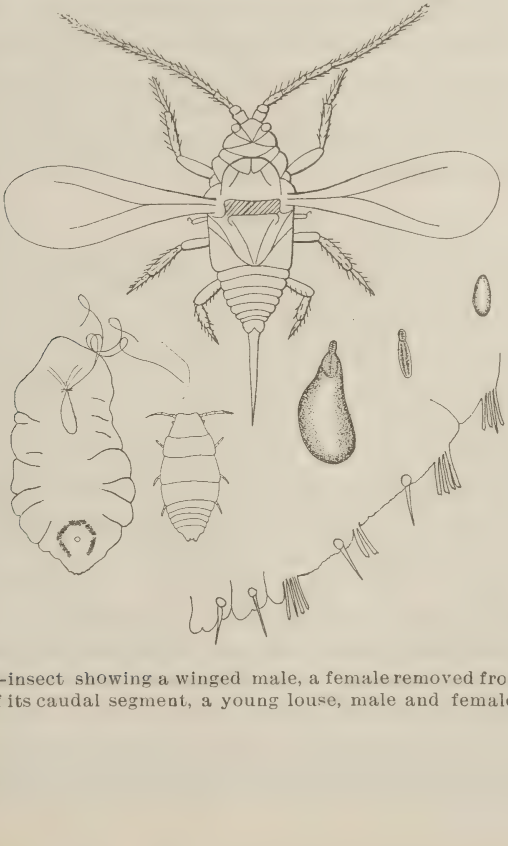

Fig. 64.—Scale-insect showing a winged male, a female removed from under the scale, the fringe of its caudal segment, a young louse, male and female scales, and egg. Original.

THE COMMON MEALY-BUG

(*Dactylopius citri* Bd.)

Everyone connected with green-houses or conservatories is familiar with the soft-bodied little bug that has a white fringe bordering its oval body and which takes its name from the mealy deposit with which it is covered. This little pest is one of the worst enemies to the florist and market-gardener. Although barely reaching one-eighth of an inch in length, it occurs in such numbers as to cause great injury to plants. The eggs of the mealy-bug are laid in a loose nest of sticky white fibres. The female usually remains on the nest until by its increase in size she is raised away from the plant, still clinging to it with the head depressed and the tail elevated in the air. When the eggs hatch, a young mealy-bug emerges, which, but for its smaller size, closely resembles the adult. The young females change very little except in size; when they are about two-thirds grown, the winged males appear and copulation takes place, and soon after this the eggs are laid for the next generation. Six weeks is the time ordinarily required to complete the cycle of life or from the time the eggs hatch till those of the next generation are hatched.

Remedies.

Mealy-bugs are well protected by the mealy covering, and as they choose plants that will not stand very harsh treatment, they are not easily combatted. In many instances, however, as on cucumbers, they may be dislodged by a strong jet of water. In case the plant is hardy enough not to be injured, a spray or dip of kerosene-emulsion (one part of emulsion to from seven to ten parts of water) will effectually check the insects. If scattered and not very plentiful, an alcoholic extract of pyrethrum (Persian insect powder) or buhach, applied with a small atomizer, will prove very efficacious.*

All these remedies have to be repeated at frequent intervals, and are consequently troublesome. No plant should be permitted to go into the green-house or conservatory before it is most thoroughly inspected. In this case an ounce of prevention is worth many pounds of cure.

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*The following was used with great success by Mr. Reid at Cornell University: alcohol, 200 cc., buhach, 50 grams. It was allowed to stand, with occasional shaking for seven or eight days, then filtered and diluted about one-half with water.

THE COTTONY MAPLE-SCALE.

(*Pulvinaria innumerabilis* Rath.)

During the first half of the summer, many kinds of trees, but most frequently the maples and box-elders, are seen to be infested with the above scale. Upon their branches small tufts of white cottony matter can be seen, which, when touched, are found to be sticky, drawing out and clinging to the finger like a spider-web.* This material is the egg-mass of the cottony maple-scale. By investigating more closely, at one end may be seen a brown or black, saddle-shaped, leathery disk, about one-eighth of an inch in diameter, usually bearing some wrinkles on its back. This disk is the body of the insect which secreted the white mass of fibres containing from 1,000 to 2,000 small pink eggs. The young lice emerge from the eggs during the late part of June or early in July, and are quite active for a time, running about freely and may at that period be carried from place to place by various means. Soon, however, they settle down and insert their long thread-like beaks in the soft bark or leaves of the plant. The body of the scale-louse is soft and quite flat, clinging closely to the surface of the tree, and so closely resembling it as to be almost indistinguishable from it. A waxy and water-proof coat is gradually formed over its skin. The male is considerably smaller than the female, and in a few weeks ceases to grow, becomes stationary and changes to a pupa inside the larval skin, which is covered with a thick coat of wax. The males emerge in August or September, and after having copulated, soon die. The fertilized females, however, continue to grow until autumn, when they migrate to the twigs and remain dormant over winter. In the spring their bodies become convex and the eggs are rapidly developed. These are laid from the middle of May or the first of June till into July.

Fig. 65 on plate 16 illustrates this insect.

Remedies.

Kerosene-emulsion diluted with water in the proportion of one part of the emulsion to about fifteen of water, is the most effective remedy and should be applied late in May or early in

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*The English sparrow, besides its other bad qualities, is in the habit of utilizing this cottony maple-scale to line its nest. In doing so the insect is carried about from park to park, and new trees are constantly being infested by this means.

June when the young are hatching and still unprotected by a waxy scale.

Many insects prey on this and other species of scales at all stages of their existence. The most effective ones are the numerous species of lady-bugs, which should consequently always be protected.

THE WILLOW OR COTTONWOOD-SCALE.

(*Chionaspis salicis* Linn.)

The trunks and branches of our cottonwood and willow trees often present a whitened appearance, which on closer examination is seen to be due to the presence of innumerable very small, papery and snow-white scales. These scales are of two forms; the female scale is the larger one and is usually more or less pear-shaped with two small, overlapping cast skins at the apex; that of the male is oblong and has three strongly marked ridges running lengthwise, while it possesses only one larval skin.

The eggs are laid under the larger and pear-shaped scale during the autumn. In depositing the eggs, the body of the female gradually shrinks away until nothing is left but a mere skin at the apex of the scale. The eggs are purple in color and very small; they hatch about the first of June into small, oval, flattened lice, which are very active, and quickly spread over the tree upon which they were born, and over such adjoining plants of the same kind as come in contact with it.

Remedies.

This insect is usually found on forest-trees where its presence is considered of little consequence, but not unfrequently it is to be seen on trees grown for shade or shelter along our streets or in wind-breaks, where its increase, if not checked, will result in the destruction of the trees. In such cases thorough spraying with kerosene-emulsion, made after the Hubbard formula, and diluted with about eight or ten parts of water, will be found effectual. As the scale under which the insect lives serves as a protection against rain, etc., the spraying must be done at a time when the young emerge from the eggs, and before they are provided with scales. This is usually about the first of June, when the numerous small reddish lice may be seen crawling in all directions about the trunks and branches of infested trees.

The Hubbard formula for kerosene-emulsion mentioned above, is given in the article about leaf-lice.

The willow or cottonwood-scale is illustrated in Fig. 66, Plate 16.

WHITE-SCALE OF THE CACTUS.

(*Diaspis cacti* Comst.)

One of the most conspicuous and beautiful of the green-house scales is the round or white-scale of the cactus. The scales possess two different forms, of which the female scale is about one-sixteenth of an inch in diameter, circular, with a dark-brown center. The male scale is about half as large, yellowish-white with a dark spot at one end, and a small ridge running the length of the scale. These scales are often very closely crowded, and if very numerous may cause the death of the plant.

The use of a stiff brush with soap and water, or a wash of kerosene-emulsion, are the most useful remedies.

An illustration showing this peculiar scale will be found in Fig. 67, Plate 16.

THE ELM-TREE WHITE-SCALE.

(*Chionaspis americana* Johnson.)

Many of the fine elms in the vicinity of St. Paul and Minne apolis are infested with small white scales closely resembling those on cottonwood, but less conspicuous, as the bark of the elm is spotted with white and therefore better adapted to conceal them, (Fig. 68, Plate 12). They are present on both the trunk and twigs. The female scale is white and pear-shaped, while the male is smaller and more slender, and has a slight longitudinal ridge. This scale is not known to be destructive at present, but notice is given so that it may be recognized should it ever become so.

THE ECCENTRIC SCALE OF THE ELM.

(*Aspidiotus ancylus* Put.)

A careful examination of our silver-maples and elms sometimes reveals the presence of a small gray scale, which so closely resembles the color and texture of the bark to which it is fastened, that it would be still more difficult to see it if it were not raised above the smooth surface of its resting place, (Fig. 69, Plate 12). The largest scales are about one-sixteenth of an inch in diameter, and somewhat circular or oval, although sometimes quite irregular in outline. The scales of this species are usually found close together in groups of all sizes, from three or four to one hundred or more. It frequently happens that the scales overlap each other, and some of them are thus pushed upon the backs of their fellows, so that they do not touch the bark at all. The advantage of a long thread-like beak possessed by scale-lice is now apparent, for with it the insect can draw its supply of food from the plant between the scales and underneath. The scale of the female has two small exuviæ, the smallest of which constitutes a yellow or orange dot placed eccentrically at one side of the center of the scale; from this the name "The Eccentric Scale" is derived. The scale of the male is smaller and has only one exuviæ. They are often so covered with secretion as to be nearly invisible.

This species seldom occurs in sufficient numbers to cause much damage, but in case it should greatly multiply it can be checked with kerosene-emulsion applied in the same manner as in the case of the others.

The specimens found in Minnesota differ from the typical form in lacking the spinnerets and the plate between the third and fourth spines, but as Professor Comstock has described a variety in which the plates are lacking it seems that it is simply a variety.

MACHINES FOR APPLYING INSECTICIDES.

As is well known, we can no longer expect rich returns from our fields and gardens without going to war with numerous insects that claim our crops for themselves. The better equipped side in this struggle is apt to come off victorious and as the insects are well prepared in this contest, it behooves farmers and gardeners to prepare equally well it not better. Our weapons against injurious insects are poisons of various kinds and machines to apply them to the best advantage. Although in many cases, and on a small scale, such poisons can be applied by hand in the form of dust or mixed with water, it is always best to apply them in a certain way by means of a specially constructed machine. To apply insecticides in a dust-like form, diluted with such other dry substances as flour, plaster paris, sifted wood-ashes, or road-dust, it is best to utilize a dust-gun, of which several kinds are in the market. If it is desirable to use insecticides wet, dissolved in water or other liquids or suspended in the same, it is important to apply them in the form of a fine spray. By spray is meant a fine mist and not a stream composed of large drops. The possession of a spraying-machine can hardly be urged too strongly to farmers, gardeners and fruit-growers. A spraying-machine, operated with a good force-pump, is useful in many ways, and will quickly pay for itself by saving poison and labor, and, at the same time, doing better execution than any application by hand. Without such machines, not only a large amount of insecticide is wasted, but the plants to be protected are not evenly covered with this protecting material. Without them portions of the plants are covered with too much poison, frequently to the injury of the plants, while others are not covered at all and consequently the insects are not prevented from eating them. A good spraying-machine, or a combination of a force-pump and spraying-nozzle, will do the required work thoroughly, rapidly and cheaply. A force-pump is always of great use on a farm, not simply against insects, but because it can be used in many other ways and for many other purposes, as for washing wagons and windows, or in case of incipient fires.

APPLICATION OF WET INSECTICIDES.

When spraying first came into practice, syringes were used. These threw streams of water broken into large or small drops, only a part of which would stick to the plant which was being syringed. This was an improvement over the sprinkling-pot, and it paved the way for better apparatus. In many places, as in green-houses, such syringes, holding a quart or two of liquid, are still in use and with good effect. When a field or orchard of any size was to be sprayed, however, the syringe was found to be inadequate, and for this purpose small force-pumps, fitted with nozzles that produced a spray, were substituted. They proved much more effectual and are, with many modifications and improvements, at the present time in general use among the more progressive agriculturists of America and Europe.

There is, at this time, a great variety of pumps, nozzles and other appliances from which it is possible to choose an outfit suited to almost any condition. In choosing an outfit, there are several important points that should be kept in mind. If the spraying is to be on a large scale, the pump should be of good size and should have an air-chamber. A small pump and a large nozzle means lots of extra work, for the pump must be driven very hard to drive the stream through the nozzle with enough force to do any good. Fig. 70 shows a type of pump much in use and very good for general purposes. The cart is very convenient in moving about among trees and in places where a wagon would be troublesome. When it is desirable, the barrel may be removed from the cart and placed in a wagon together with several spare barrels filled with the prepared insecticide. This may be driven to the infested place and the spraying can be done from the wagon. A very handy form of pump for gardens, lawns, small orchards, and green-houses is that shown in Fig. 71. In this case the liquid is carried in a pail while the pump is held in position by placing the foot on a rest outside. Fig. 72 shows such a pump in operation. An-

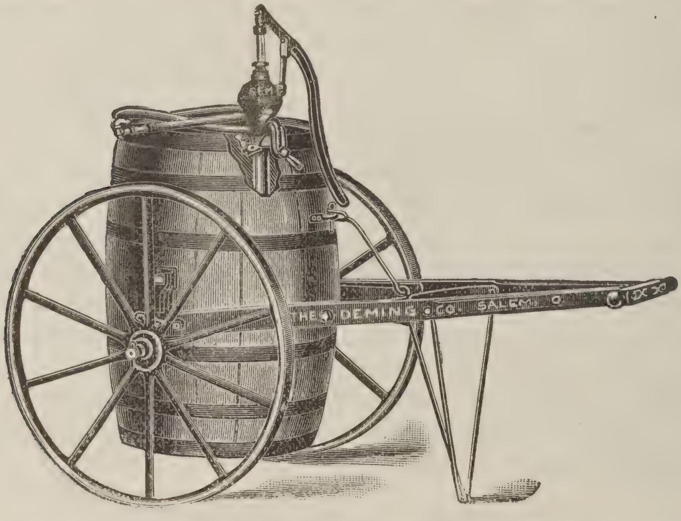

Fig. 70.—The above cut represents the "Gem" Spray Pump attached to Barrel Cart.

other type very much in favor, especially for spraying potatoes and small fruit. as well as shrubs and small trees, is the

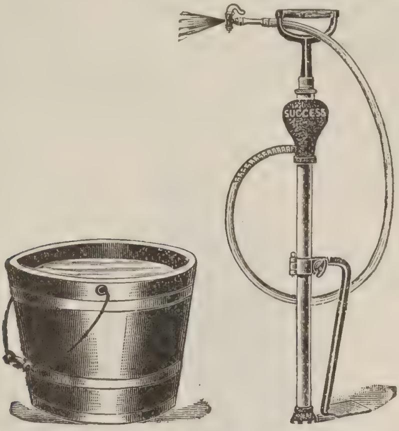

Fig. 71, showing position of foot-rest and manner of placing Pump in bucket.

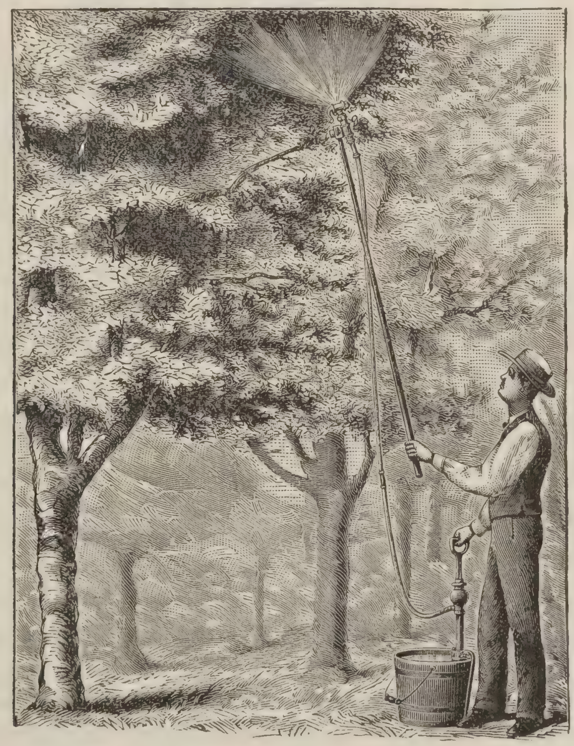

Fig 72.—Spraying-pump in operation.

knapsack-sprayer, shown in Fig. 73. This is a very convenient arrangement. It can be readily carried anywhere, and when on the back, is easily shaken so as to keep the liquid well stirred. The knapsack-sprayer shown in the figure, has an attachment by means of which kerosene may be mixed without the trouble of previously preparing an emulsion. The small tank is filled with kerosene and the larger one with water. A stop-cock with a graduated scale over which its handle moves, allows the two liquids to come together in or near the nozzle in any proportion, from three to fifty per cent of kerosene.

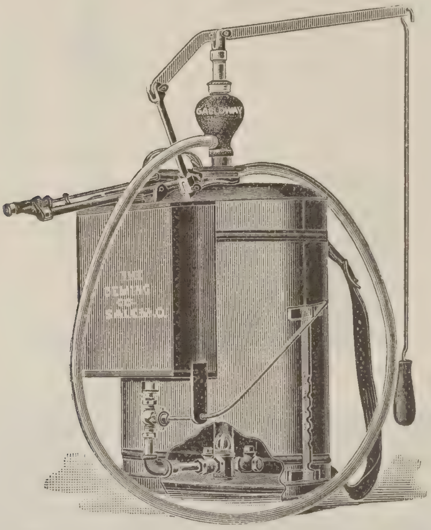

Fig 73.—Knapsack-sprayer with kerosene tank.

A very important part of the spraying-outfit is the nozzle, and a great variety of these are now in the market. There are nozzles that throw a solid stream (good for watering lawns and washing carriages), and some that produce a very fine mist; some have a fairly long range and others work only at a short distance. Others again throw a fan-shaped spray and still others a spray in the form of a funnel. Many clog easily but a few are self-cleaning. Among all these nozzles the qualities that are desired are evenness of distribution, economy, freedom from clogging, and the production of a fine spray which issues with great force, as a spray should strike the plant and not simply fall on it. Fig. 74 shows a type of nozzle which is efficient and much used. The spray from it is fine and funnel-shaped. A small button, when pressed, clears the aperture in case of clogging. The caps, through which the spray issues, are inter-changeable and furnished with apertures of different sizes, so that variation in the size and range of the spray can be easily obtained. Fig. 75 shows a nozzle which, although not so well known, is becoming a favorite. It has the advantage of being automatically self-cleaning. When clogged, the pressure drives a spring back and allows the impediment to be driven out; it also closes itself as soon as the pumping stops, thus preventing leakage. The spray is fan-shaped and the range capable of adjustment. It is very useful, especially in orchards. A nozzle with a great and well-founded reputation is the "cyclone nozzle." It takes its name from the rotary motion of the cone-shaped spray. The stream enters the chamber, which contains the exit-orifice, in a tangential direction, producing a rotary motion which is communicated to the cone of fog-like mist which constitutes the spray. This nozzle is very useful for many purposes. It is usually set so that the spray comes out at right-angles to the handle and is, for this reason, very effectual in getting under vines and bushes. The Nixon nozzle produces a spray by driving a small, solid stream through a wire-netting. These nozzles are furnished with meshes of various sizes so as to produce a fine spray or one of greater range. It is

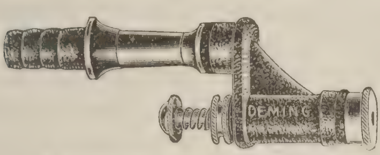

Fig. 74.—Deming—Vermorel spray-nozzle.

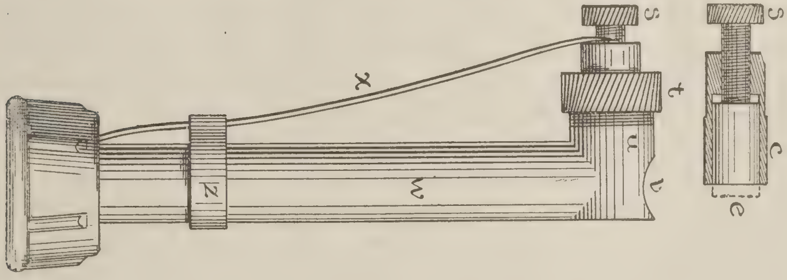

Fig. 75.—McGowen automatic self-cleaning nozzle.

very useful for clear liquids, but is liable to become clogged with heavy ones, such as Bordeaux mixture.

All spraying machinery should be carefully cleaned after use. With good care an outfit may be made to last for many years, but if neglected it soon becomes useless. The formulæ for using Paris-green and London-purple are given in the article on potato-bugs, and the formula for kerosene-emulsion is given in the article on leaf-lice.

THE APPLICATION OF DRY INSECTICIDES.

Although usually less economical, it is sometimes desirable to dust plants with dry insecticides. This is done in many ways. The old way was to tie up the insecticide mixed with plaster, flour, air-slaked lime or some such powder, in a muslin sack, and to shake this over the plants to be poisoned. This is a very convenient and efficient method when only a few plants are to be dusted. For applying dry poisons on a large scale, various appliances have been devised. The powder-bellows is a simple arrangement by means of which a blast of air from the bellows is made to carry the dust-like insecticide to the place for which it is intended. Another device for the same purpose is the Orchard-gun. In it a small fan, about four inches in diameter, is driven very rapidly by means of crank and multiplying gears so arranged that one revolution of the crank gives thirty revolutions of the fan. In front of this fan is an arrangement for sifting the powder into the current of air, thus charging the blast with the insecticide which is carried along with it and discharged in a smoky cloud which settles on the foliage. It is always best to apply dust when the dew is on the plants, or just after a rain, as moisture is required to hold the poison to the foliage; otherwise the first wind will blow it away. It is never safe to use dry insecticides near pastures or where it is liable to be blown onto the food of cattle or horses.

CUT-WORMS.*

The term cut-worm applies to caterpillars which have the injurious habit of cutting off or cutting into the food plants, so as to wilt or kill them. Usually this takes place in the early spring, and only very seldom later in the season. This peculiar habit, so well known to farmers, gardeners and florists, is evidently caused by the fact that such caterpillars prefer wilted to more succulent food. This preference to wilted food seems to be a very general rule among all insects, since but very few enjoy very succulent foliage, but become sick if forced to consume it. Preferring more mature leaves or foliage not filled with sap, they select this more suitable food later in the season, and as at that time there is an abundance of it the caterpillars are not forced to prepare it for themselves by cutting off the plants. Early in the spring matters are different; all the plants are just unfolding their new foliage or forcing their first delicate leaves full of sap towards the light. The warm and genial air of spring, which starts all vegetation for a new cycle of life, also awakens such young caterpillars as hibernate. After the long fast, enforced by cold and absence of food, their natural voracity is still greater than usual, and they are not slow to attack their food-plants which are, however, not yet in a suitable condition, being still too watery. The only way for the caterpillar to overcome this state of affairs is either to continue starving and wait for better times, or to solve the question of food-supply by cutting off the succulent plants and wilting them. This done the food is in a palatable condition for them. For this reason we have cut-worms only in the spring, and not late in the season. This peculiar habit of cut-worms of preparing their food is a habit we can make use of to lessen their injuries and to kill them. Knowing that such insects prefer wilted foliage we can supply this, and be certain that they will accept such a kind invitation by eating the food. If we poison the wilted food we furnish our enemies, the cut-worms will be killed in large numbers. The proper way to carry out this plan is to tie together small bundles of such plants as grass, clover, or any surplus of young cabbage-plants we may have to spare. These bundles, which should be about three inches in diameter, after being dipped in water containing a large amount of Paris-green or London-purple, are now laid among the rows of plants that we wish to protect. Our traps or baits are now ready for action. The bundles should be laid about six feet apart and only in such parts of the fields or gardens as will be first reached by the cut-worms. Close attention will show that not all parts of the garden or fields are equally infested with cut-worms, but that they invade certain places from one or more well defined directions. As cut-worms hibernate they usually select those suitable places as offer superior shelter and good drainage, consequently the more elevated parts of the ground, or soil well overgrown with grass. The former gives good drainage, the latter good shelter. Such places can be easily detected in any garden, and by laying our traps in their vicinity most of the cut-worms will find them and be killed before reaching other parts of the field. Whoever applies such remedies must not expect that he will find large numbers of dead cut-worms on the surface of the ground or under the bait, as such is not the case. The caterpillars, having eaten of the prepared bait, soon feel the effects of the poison, and will be kept running about by the resulting pains. In a number of cases, where crops of onions were badly infested, and where this remedy was applied, a close search was made for dead cut-worms. It was found that under the baits a number of cut-worms were dead or in a dying condition, but more were found as far as ten feet from the baits. These dying cut-worms were not found on the surface of the ground but they had burrowed into it in the usual way, and were dying in such situations.

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* The illustration, Fig. 76, Plate 11, shows a number of our common cut-worms.

Another, and a very effective bait, which is mentioned in the article on Migratory Locusts, is also an excellent one to use against cut-worms. It is a bait made of rye flour, or rye and wheat bran, mixed well with one of the arsenical poisons. The mixture should contain enough Paris-green or London purple to become distinctly colored by these substances. If a tablespoonful of such bait is dropped near the plants to be protected the worms will not be slow to find and to eat it. Such baits are especially valuable in case the plants to be protected are grown upon land which but shortly before was a meadow, pasture or timothy field, as fields in which the sod has not been disturbed for some years form the homes and very head-quarters of cut-worms. In such a case the baits should be prepared and laid before the young plants appear above the surface of the ground.

There is another habit of the cut-worms of which we can make use in combatting them. They, like some more highly organized beings, do not like to work more than is absolutely necessary. As it is important for them to hide under the soil or elsewhere during the day, so as to escape their enemies, they are forced towards morning, after each nocturnal feast, to burrow again or search for shelter. This they do as a general rule close to the plant that they infest. If we furnish them a handy shelter they will very often utilize it. By placing on the ground, near the plants to be protected, such objects as pieces of boards, shingles, or even flat stones, we induce many cut-worms to utilize them as shelters and here they remain all day. Large numbers can thus be discovered and captured during the day, and should be killed.

Though there are a number of climbing cut-worms which infest orchards, we have not many in Minnesota that injure fruit trees. If trees should suffer, however, it is not difficult to prevent the worms from reaching the foliage. All that is needed is to make a thick ring of "Raupenleim" around the trunk; this sticky material will prevent any insect from crawling over it, and as it possesses at the same time a strong and repelling odor it is a very useful material for many purposes. The great majority of our native species do not climb, and are very much opposed to undertake such extra labor. Indeed it is doubtful if some of our cut-worms could climb trees if they wanted to. At all events they can not climb upon anything that is smooth, and their inability to do so gives us another method to out-general this enemy. The remedy, based upon this habit, can not, however, be applied upon a large scale, as it requires considerable labor, but whenever only a few hundred or thousand plants need protection it can be used with great success. By removing the tops and bottoms of tin cans that can be found in such abundance almost anywhere, and by removing the solder, we have an excellent material to protect our plants against cut-worms. The best method would be to have strips of such tin about three inches wide and long enough to be bent into a circle at least an inch and one-half in diameter. These strips are to be bent so as to form a sort of spiral collar, which can be slipped around the plants very readily without endangering their leaves. This protective collar should be pressed into the ground at least an inch deep, so that the plant is as thoroughly protected against the cut-worms from below, provided, however, that the culprit be not inclosed within this circle. Such tin collars can be made during the time when there is little work on hand, and once made, if taken care of, they will last for many seasons. They are readily applied and as readily removed when the danger is over, when they should be stored away for future use. Of course other substances could be substituted for such tin collars, such as stiff paper, but such substitutes never last as well as those made of tin, and a heavy rain is apt to ruin them, nor are they so readily applied as the more elastic collars of metal.

There is still another way to protect our plants against cut-worms, and a very simple and effective one at that. Cut-worms, like all other caterpillars, chew their food, and by coating the plants to be protected with either Paris-green or London-purple, we can readily poison the caterpillars that attack such plants. This method would be a very simple one, if all gardeners and farmers possessed good spraying machines, which would spray uniformly all the exposed parts of the plants, of course including the stem, but such is not the case. Besides, in many cases the stems of young plants are cut off below the surface of the ground, where arsenical poisons can not be applied. One thing is certain, that farmers, gardeners and florists can prevent any great loss by cut-worms if they apply one or more of the above remedies in a thorough manner.

It is well known that the parents of cut-worms, or the owlet-moths, can be readily captured by certain baits, which are brushed upon trees or fences. Immense numbers of such moths are attracted by them and can be killed by mixing such baits with arsenical poisons. This would seem to be an excellent remedy, but when we dissect the owlet-moths thus caught we find that a large number of them have already deposited their eggs, and have therefore done all the mischief they could do. Of course a large number of the parents of cut-worms still containing eggs could thus be killed, but it requires much more attention than most farmers are willing to give. Moreover as the moths just poisoned fly about for some time before dying they may cause the death of such animals as eat them. Domestic fowls would be very apt to suffer, and we would also risk the lives of a large number of beneficial birds and such nocturnal animals as the mouse-like shrews.

For an entomologist, who wishes to study the owlet-moths of any region in a short time. there is no better method than to "sugar" for them. This is the technical name for applying a bait composed of the cheaper grades of molasses, sugar and vinegar. This mixture, if kept warm, will soon start a vinous fermentation. which seems to have a wonderful attraction for all owlet-moths that take food in that stage. For a number of years sugaring was carried on by myself at the Agricultural School, and immense numbers of moths were captured. The above mixture, which is of a treacle-like consistency, was brushed against the trees, and proved such an attraction that on certain evenings moths came in such numbers as to appear like swarming bees. The following list has been prepared to show the species of owlet-moths captured. and also to show the time at which they fly about to reproduce another generation. The list contains the names of all noxious cut-worms, and may on that account be considered of practical importance.

Strange insects are sometimes caught at such baited trees, insects that have never been found breeding in the north. For instance it is a common occurence to see large numbers of the cotton-moth fluttering around such baited trees. They are found only very late in the autumn, and always appear as if freshly issued from the pupa. This is very remarkable indeed, when we consider that such insects must have flown over that tremendous territory separating the wheat-belts of the north from the cotton-belts of the south.

The most destructivespecies are marked with a star.

LIST OF OWLET-MOTHS TAKEN ON SUGAR AT ST. ANTHONY PARK.

HETEROCERA.

NOCTUINA.

Thyatiridæ.

Thyatira scripta Gosse June 10, July 1 (Duluth†)	Rare.
Pseudothyatira cymatophoroides Gn. June 30, July 13	Not common.
var. *expultrix* Grt. July 1, 2, 14, 19	Not common.
Leptina ophtalmica Gn. (Duluth)	Rare.

Noctuidæ.

Panthea furcilla Pack. (Duluth)†	Not common.
Arsilonche albovenosa Goetze(bred in early spring)(Duluth)	Common.
Acronycta loheliæ Gn. March, May 14, June 22, July, Aug. 5	Common.
grisea Walk. June 9, 12, 16, 21, 28. (Duluth)	Not common.
albarufa Grt. June 27, 29, July 2	Not common.
populi Riley. March (bred) (Duluth, July 11)	Not common.
americana Harr. June 12, 21, 22, 25	Common.
dactylina Grt. June 7, 16, 19, 25, July 2, 3, 14	Very common.
acericola Gn. (Duluth)	Not common.
luteicoma G. & R. June 13, 14, 20	Rare.
brumosa Gn. July 8, 22	Very common.
superans Gn. Sept 14	One.
ovata Grt. June 25, 27, July 7	Not common.
modica Walk. June 19, 29	Not common.
hamamelis Gn. June 29, 30	Not common.
haesitata Grt. June 12, 20	Rare.
sperata Grt. June 10, 16, 17, 19, 21, 26	Common.
lithospila Grt. (March 15 bred.) June 17, July 1	Not common.
oblinita S & A. (Feb. 25, bred) (Duluth)	Not common.
Microcœlia diptheroides Gn. June 13, July 6	Common.
var. *obliterata* Grt. June 13, 19	Not common.
Bryophila lepidula Grt. June 16, 17, 19, 23, July 20	Fairly common.
teratophora H. S. June 9, 13, 17, 23	Fairly common.
Rhynchagrotis chardinyi Bdv. (Duluth.)	Not common.
minimalis Grt	Rare.
alternata Grt. July 1, 3, 6, Aug. 5, 7, 16, Sept. 3, 9, 29, Oct. 16	Common.

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†Most of the moths marked "Duluth" were captured by Mr. A. Bolter, from Chicago, an indefatigable collector of insects.

Adelphagrotis prasina Fabr. June 29, July 2, 4, (Duluth.) Not common.
Platagrotis pressa Grt. (Duluth.)........................Not common.
**Eueretagrotis sigmoides* Gn. July 12, 13, 19, 20...........Common.
perattenta Grt. June 29..........................One.
Semiophora elimata Gn. (Duluth.).......................Not common.
Pachnobia ferruginoides Smith (Duluth.)................Not common.
**Agrotis ypsilon* Rott. June 9, 20, July 19, Aug. 17, 22, Sept. 3, 22, Oct. 5.......................Very common.
Peridroma occulta Linn. May 2, Aug. 8, (Duluth.)......Not common.
**saucia* Hbn. March 15, July 25, Aug. 3, 11, Sept. 1, 19.......................................Very common.
**Noctua baja* Fabr. Aug. 5, 13, 30, Sept. 9..............Very common.
**normaniana* Grt. July 31, Aug. 15, 22, 23.......Very common.
**bicarnea* Gn. July 30, Aug. 1, 3, 25..............Very common.
**c-nigrum* Linn. June 11, 24, 28, Aug. 3, 15, Sept. 2, Very common.
oblata Morr. (Duluth.)........................ Not common.
**fennica* Tausch. June 29, Aug. 12, 26, (Duluth.). Very common.
**plecta* Linn. June 2, 9, 11, 28, July 9, 27, Aug. 14. Very common.
collaris G. & R. June 29, Sept. 1, 8...............Not common.
**haruspica* Grt. June 21, 30, July 1, 6, 15, 26, July 30, Aug. 1...............................Very common.
**clandestina* Harr. June 8, 24, 30, Aug. 1, Sept. 3. Very common.
Chorizagrotis introferens Grt. June 11...................Three.
agrestis Grt. July 8..............................Two.
**Feltica subgothica* Steph. July 25, 29, Aug. 2, 3, 13, 24, Sept. 3...................................Common.
**volubilis* Grt. May 16, June 9, Sept. 2, 16.........Common.
**annexa* Tr...................................One.
**Porosagrotis vetusta* Walk. Aug. 19, 20, 27, Sept. 4.......Common.
Carneades niveilinea Grt. Sept. 2, 7.....................Common.
**velleripennis* Grt. June 30, Aug. 17, 29, Sept. 2, (Duluth.) ....Common.
scandens Riley, (Duluth)........................Not common
detersa Walk. Sept. 3..........................Two.
**messoria* Harr. June 19, July 1, 4, Aug. 3, 14, 15, 17, Sept. 6, 18...........................Very common.
insignata Walk. June 29, July, Aug. 2, Sept. 1. (Duluth)........... ....Common.
**tessellata* Harr. July 6, 22......................Common.
albipennis Grt......................... ....Not common
ochrogaster Gn. July 2, Aug. 23, (Duluth).......Two.
obeliscoides Gn. Aug. 16, 24.................... .....Not common.
**Anytus sculptus* Grt. Sept. 4, 9, 19.....................Common.
Copipanolis borealis Smith. April 15....................Two.
Mamestra imbrifera Gn. June 29, 30, July 2, 13...........Not common.
purpurissata Grt. Aug. 22, 23, Sept 2 ....Not common.
lustralis Grt. June 17, 25, 27, 29..................Not common.
detracta Walk. June 6, 7, 27, July 14............Common.

Mamestra meditata Grt. Aug. 5, 6, 14, 20, 26.............Common.
atlantica Grt. June 9, 22, July 1, 24, 27, Aug 3....Common.
subjuncta G & R. June 10, 26, July 8, 24, Aug. 15.Common.
grandis Bdv. May 15, 20, June 9, 10, 15, 20, July 3, 22, 27, Aug. 1, 3, 5, 16....................Common.
**trifolii* Rott. June 9, 10, 15, July 6, 22, 31, Aug. 1, 3, 7, Sept. 1............................Very common.
rosea Harv. June 10, 22, 26.....................Not common.
**picta* Harr. April 24, June 5...................Common.
cristifera Walk. June 12, 17, July 8.............Not common.
assimilis Morr. April 27.........................One.
latex Gn. June 18, 20...........................Two.
adjuncta Bdv. (March 1, bred), June 10, 24, July 20, Aug. 1, 5, 20.........................Common.
ligitima Grt. (Duluth).........................Not common.
lilacina Harv. July 24, 27, Aug. 1, 2, 4.........Not common.
renigera Steph. June 29, July 22, 25, Aug. 2, 24, Sept. 1................................Common.
olivacea Morr. June 10, 13, Aug. 3, 13, 26, 17.....Not common.
lorea Gn. June 9, 20.............................Not common.
vicina Grt June 12, 13,.........................Not common.
Hadena niveivenosa Grt. (Duluth.)......................One.
stipata Morr. Aug. 15...........................One.
remissa Hbn. July 1, 18. (Duluth)..............Two.
suffusa Morr. July 2............................One.
apamiformis Grt. July 1, 3, 27..................Not common.
lateritia Hbn. June 27, 29, 30, (Duluth.)..........Not common.
sputatrix Grt July 1, 22, Aug. 1, 3, 19..........Common.
plutonia Grt. June 19, 27.......................Two.
ducta Grt. July 4, 30, (Duluth.)..................Not common.
impulsa Gn. (Duluth.)...........................Not common.
**devastatrix* Brace. June 2, Aug. 16, 22...........Very common.
**arctica* Bdv. June 16, 24, 30, July 21, 30, 31, Aug. 3Very common.
verbascoides Gn. June 29, 30, July 4, 29...........Not common.
cariosa Gn. June 16, 30, July 1, 8.................Not common.
**lignicolor* Gn. June 17, 27, 30, July 1, 3, 11.......Very common.
leucoscelis Grt. Aug. 13, 15......................Two.
modica Gn. June 19, July 6, Aug. 3...............Not common.
mactata Gn. June 10, July 9, Aug. 30, Oct. 1.....Common.
fractilinea Grt. June 19, 29, July 4, 20, 27, Aug. 2, 4, 6, 15, 25..............................Very common.
misera Grt. Aug. 2..............................One.
Hillia senescens Grt. June 16...........................One.
Oligia versicolor Grt. (Duluth.) ....Not common.
Perigea luxa Grt. July 3, 20, 24, Aug. 3, 6, Sept. 2.........Very common.
Dipterygia scabriuscula Linn. May 17, June 8, 15, 24, July 9, 27, Aug. 1, 3...........................Very common.

*_Hyppa xylinoides_ Gn. June 31, Aug. 1, 3, Sept. 1, 9, 18....Very common.
Actinotia ramulosa Gn. Aug. 30........................One.
Laphygma frugiperda S & A. Var. _obscura_ Ril. Sept. 3, 15..Not common.
Prodenia lineatella Harv. Sept. 19......................Not common.
Brotolomia iris Gn. June 4, 10, 16, 20, 21, (Duluth.).......Common.
Euplexia lucipara Linn. June 17, 26, 27..................Common.
*_Nephelodes minians_ Gn. Aug. 25, Sept. 1, 5..............Common.
Helotropha reniformis Grt. June 27, July 8, 23, 29, Aug. 24, Sept. 9, 15............................Common.
Hydrœcia velata Walk. June 29, 30, July 6, 27, Aug. 2.Common.
nictitans Bkh. June 29, July 6, Aug 1, 2, 6,.....Common.
rigida Grt...................................One.
purpurifascia G. & R. Sept. 4,..................Two.
Arzama obliquata G. & R. (bred June 2.) (Duluth.)......Two.
Platysenta videns Gn. July 22, 25, Aug. 1, 3............Not common.
*_Leucania pallens_ Linn. July 25, 31, Aug. 1, 19, 29, Sept. 2, 4....................................Common.
rufostrigata Pack. July 26, Aug. 1...............Two.
*_albilinea_ Hbn. June 5, July 20, 31, Aug. 1, 2, 13, Sept. 15................................Very common.
lapidaria Grt. Aug. 19..........................One.
phragmatidicola Gn. June 10, Aug. 1, 24.........Common.
commoides Gn. June 29, July 25..................Common.
*_unipunctata_ Harv. June 24, 29, July 7, 23, Aug. 20, 25, Sept. 2, 15, 17.....................Very common.
pseudargyria Gn. June 29, July 2, 6, 16, 19, 30....Very common.
Nolophana malana Fitch. June 19, July................Three.
Caradrina miranda Grt. Aug. 16.......................Two.
multifera Walk. June 12, 16....................Two.
*_Pyrophila pyramidoides_ Gn. Aug. 20, Sept. 10, 25, Oct. 3.Common.
Orthodes infirma Gn. July 1, 14.........................Very common.
cynica Gn. June 9, 13.......................... .Very common.
Crocigrapha normani Grt. June 9.......................One.
Taeniocampa oviduca Grt. June 9, 13...................Not common.
thecata July 6, 26............................Three.
Cosmia paleacea Esp. Sept. 5..........................One.
Parastichtis discivaria Walk. (Duluth.)..................Not common.
Pyrrhia umbra Hbn. (bred) June 7, 10, 13, 30, July 4, 14, Aug. 1, 5, 14............................Very common.
Orthosia ferruginoides Gn. Aug. 3, 27, Sept. 1, 6, 15, 19, Oct. 1.................................. Very common.
euroa G. & R. July 30, Aug. 28, Sept. 1, 15, 16..Very common.
helva Grt. July 21, 27, 31, Aug. 1, 4, 27............Very common.
Xanthia flavago Fabr. Sept. 13, 15.....................Not common.
Jodia rufago Hbn. April 11, 18........................Common.
Cirroedia pampina Gn. Aug. 31, Sept. 1, 3, 10.............Common.
*_Scoliopterix libatrix_ Linn. July 6, 24, 27, Aug. 14, 17, 22 Sept. 17, 19..............................Common.

Scopelosoma tristigmata Grt. April 15, 17, 18	Common.
walkeri Grt. April 10, 14	Common.
sidus Gn. April	Common.
devia Grt. April 7, 14, 25	Common.
Xylina petulca Grt. April	One.
ferrealis Grt. April. All Sept.	Common.
bethunei G & R. March 3, 15, April, May 3, Sept 16, Oct. 1	Common.
laticineria Grt. April 21, 22, Sept. 16, Oct 3	Common.
Calocampa nuperi Lint. April	Common.
cineritia Grt.	Not common.
curvimacula Morr. March	Not common.
Cucullia asteroides Gn. June 6, 26	Not common.
Marasmalus histrio Grt. June 17, July 9	Common.
Aletia argillacea Hbn. Sept. 15, 19	Very common.
Ogdoconta cinereola Gn. July 9, 23, Aug. 5, 20	Very common.
Plusia aerea Hbn. Sept. 5	One.
balluca Geyer. July 3	One.
contexta Grt.	One.
precationis Gn. June 16	Not common.
**brassicæ* Ril. July 18, Aug	Very common.
u-aureum Bdv. (Duluth.)	Not common.
mortuorum Gn. (Duluth.)	Not common.
angulidens Smith. (Duluth.)	Not common.
**simplex* Gn. June, Aug. 6, 28, Sept. 19	Very common.
Calpe canadenis Beth. Aug. 28	One.
Plusiodonta compressipalpis Gn. Aug. 4	Two.
**Heliothis armiger* Hbn. Oct. 1	Not common.
phlogophagus G & R. June 1, Oct. 5, (Duluth)	Not common.
Alaria florida Gn	One.
Schinia arcifera Gn. Aug. 6	Not common.
jaguarina Gn. (Duluth)	Not common.
Acontia cretata G. & R. June 2, 8	Not common.
Chamyris cerintha Tr. June, July 13	Common.
Metathorasa monetifera Gn. June 29, 27, 30	Common.
Euherrichia mollissima Gn. June 19	One.
Erastria synochitis G. & R. July 2	One.
muscosula Gn. June 10, July 7	Common.
apicosa Harv. June 26, 29, July 23, Aug. 24, all Sept	Common.
carneola Gn. June, July, all Sept.	Common.
Galgula subpartita Gn	One.
**Drasteria erechta* Cram. May 3, Sept. 1	Common.
*var. *agricola* G. & R. July 29, Aug. 3	Common.
**erichto* Gn. July	Common.
**Euclidia cuspidea* Hbn. May, June 9, Aug. 1	Common.

Catocala amica Hbn. July, Aug. 20, Sept. 15	Very common.
grynea Cram. Aug. 3	One.
abbreviatella Grt. July 20	One.
nuptialis Walk. July 18	One.
cerogama Gn. Aug. 3	Not common.
ilia Cram. Aug. 11 (bred)	Not common.
parta Gn. July 17	One.
unijuga Walk. Aug. 3, Sept. 3, 15	Common.
electilis Walk	Three.
luciana Hy. Edw. Aug. 1	Two.
concumbens Walk. July 24, 31, Aug. 5, Sept. 17	Very common.
amatrix Hbn. Aug	Not common.
relicta Walk. Aug. 5, Sept. 19	Two.
paleogama Gn.	One.
Phoberia atomaris Hbn. May (bred)	Not common.
Parallelia bistriaris Hbn. July. (Duluth.)	Not common.
Agnomonia anilis Dru. June 29	One
Panapoda rufimargo Hbn. June 10,19,27, July 2. (Duluth.)	Common.
Erebus odora Linn	One.
Pheocyma lunifera Hbn. May 30, June 18	Not common.
Homoptera edusa Dru. June. (Duluth.)	Not common.
var. *lunata* Dru. June 11, Aug. 2	Common.
Ypsia undularis Dru. May 6, 19	Not common.
Pseudanthrœcia coracias Gn. June 17	One.
Homopyralis discalis Grt. June 7	Not common.
tactus Grt. June 30, Aug. 3	Not common.
Pangrapta decoralis Hbn. (Duluth.)	Not common.
Pseudaglossa lubricalis Geyer. June 26, 29, July 25, Aug. 4.	Common.
Epizeuxis œmula Hbn. June 19, 29, July 7, 20, Aug. 2, (Duluth)	Common.
americalis Gn. June 16, 29, Aug. 3, 16	Common.
Herminia petrealis Grt. June 16, 19	Not common.
Zanclognatha lævigata Grt. July 22	Not common.
Pallachira bivittata Grt. July 22	One.
Philometra eumelusalis Walk. (Duluth.)	Not common.
Palthis angulalis Hbn. June	Two.
asopialis Gn. (Duluth.)	Not common.
Bleptina caradinalis Gn. June 29	One.
Bomolocha baltimoralis Gn. June 17	Not common.
abalinearis Walk	Not common.
Hypena scabra Fabr. June 29, July 2, Sept. 1, 9, Oct. 15	Very common.

EXPLANATION OF PLATES.

Plate 1, fig. 10.—Jars, etc., in which spores are produced on a large scale; round tin boxes in which spores were mailed.
" 1, fig. 11.—Large and small sterilizers.
" 1, fig. 18.—Cabbage worms killed by bacterial disease.
" 2, fig. 8.—Plate cultures of two different ages.
" 2, fig. 12.—Dead grasshoppers covered with mycelium.
" 2, fig. 13.—Bag-worm killed by and covered with mycelium.
" 3, fig. 29.—Two hopperdozers tied together.
" 4, fig. 30.—Single hopperdozer at work.
" 5, fig. 36.—Colorado potato-beetles and two species of blister-beetles.
" 5, fig. 45.—Currant-borer.
" 5, fig. 51.—Unknown borer.
" 6, fig. 37.—Stages of Imported Cabbage-butterfly, Cabbage Zebra-caterpillar, Cabbage Plutella and its parasites.
" 7, fig. 38.—Stages of Native Cabbage-butterfly and Cabbage Plusia.
" 8, fig. 42 —Currant leaf-lice.
" 8, fig. 47.—Work of Plum-tree borer.
" 8, fig. 63.—Cockscomb-gall on elm.
" 9, fig. 52.—Box-elder Leaf-folder and its parasites.
" 10, fig. 53.—Trees more or less infested with Box-elder Leaf-folder.
" 11, fig. 54.—Stages of Sweet-corn moth and Rosin-weed moth.
" 11, fig. 76.—Adults of six species of common cut-worms.
" 12, fig. 55.—Parsley butterfly.
" 12, fig. 68.—Elm-tree White-scale.
" 12, fig. 69.—Eccentric scale of the elm.
" 13, fig. 57.—Stages of Box-elder bug.
" 14, fig. 58.—Stages of Bean-fly.
" 14, fig. 62.—Winter eggs of leaf-lice on plum twig.
" 15, fig. 59.—American Meromyza, its work, and parasite.
" 16, fig. 66.—Willow or Cottonwood-scale.
" 16, fig. 65.—Cottony Maple-scale.
" 16, fig. 67.—White-scale of Cactus.
" 16, fig. 28.—Egg-masses of Pellucid locust.

PLATE 1.

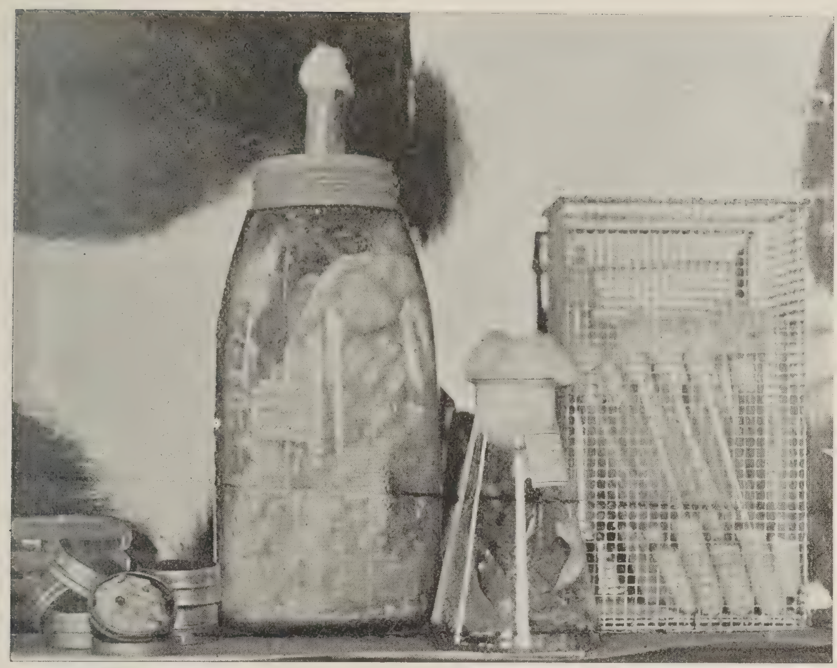

FIG. 10.

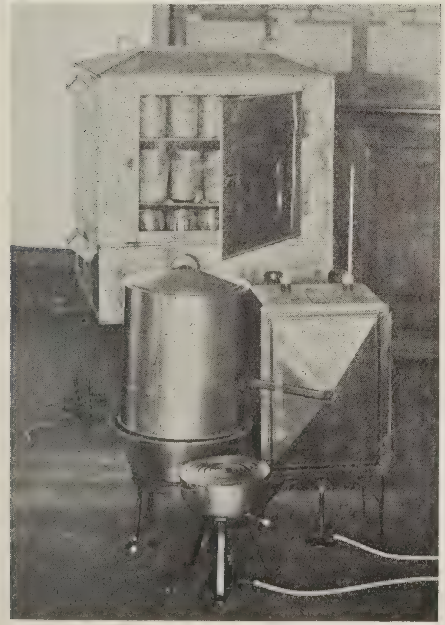

FIG. 11.

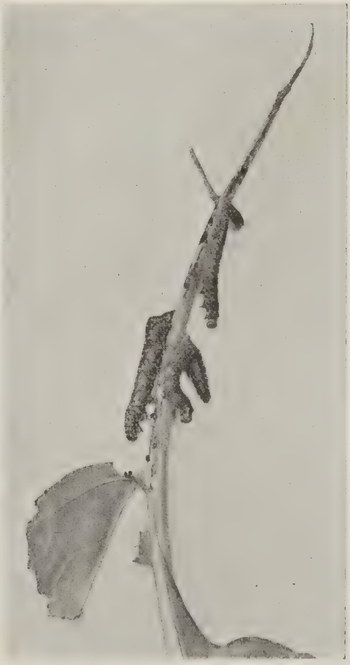

FIG. 18.

PLATE 2.

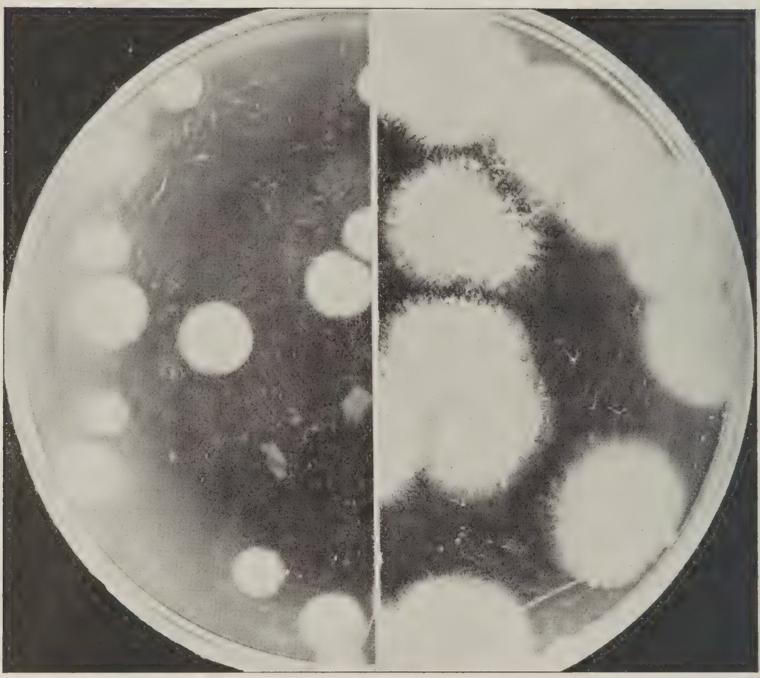

FIG 8.

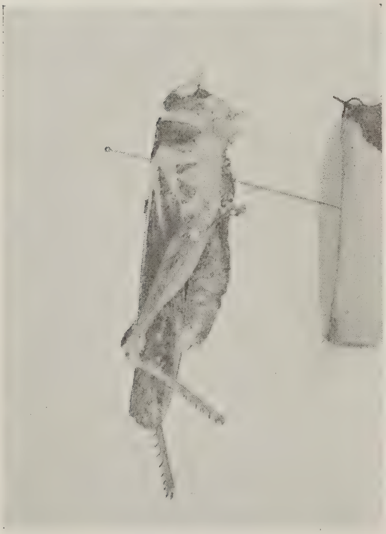

FIG. 12.

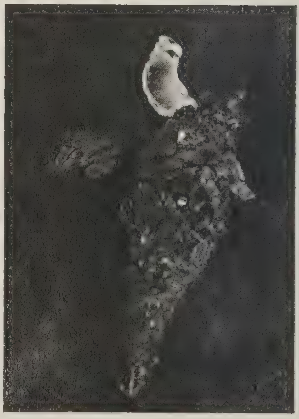

FIG. 13.

PLATE 3.

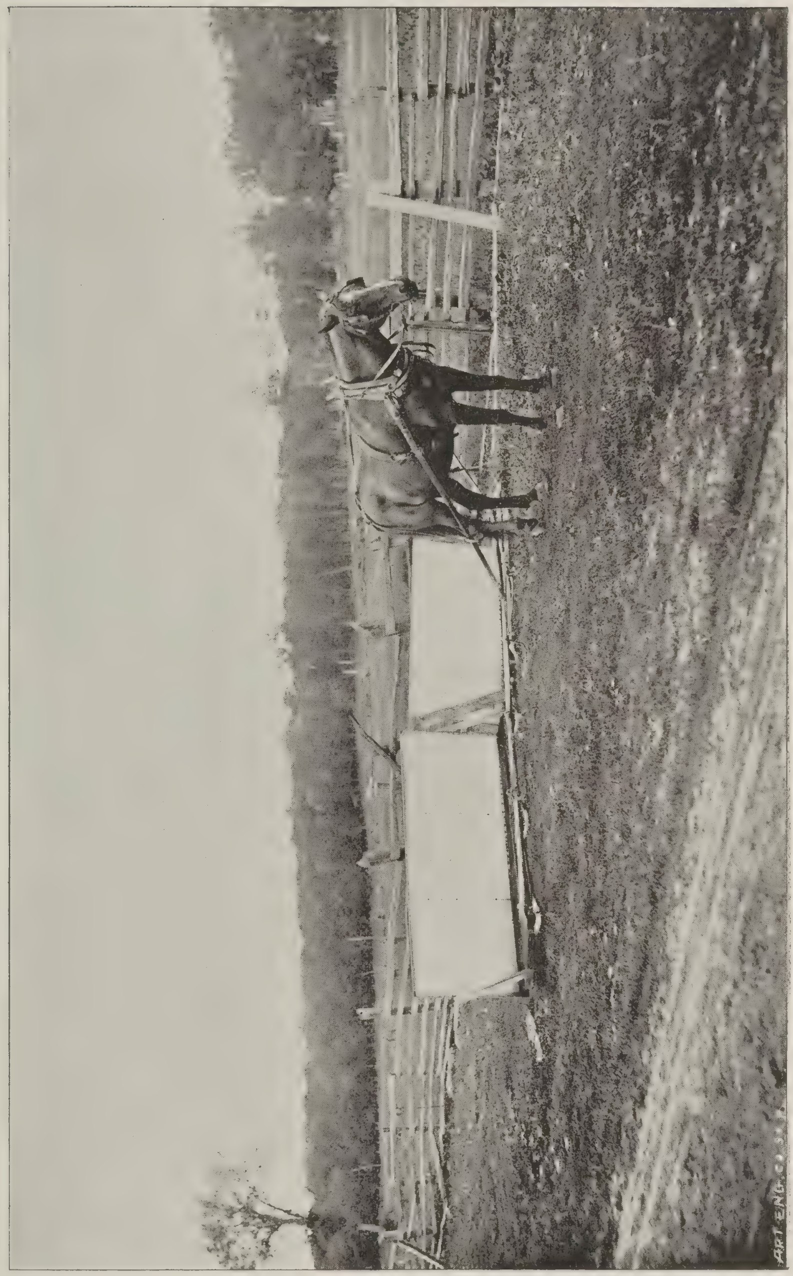

FIG. 29.

PLATE 4.

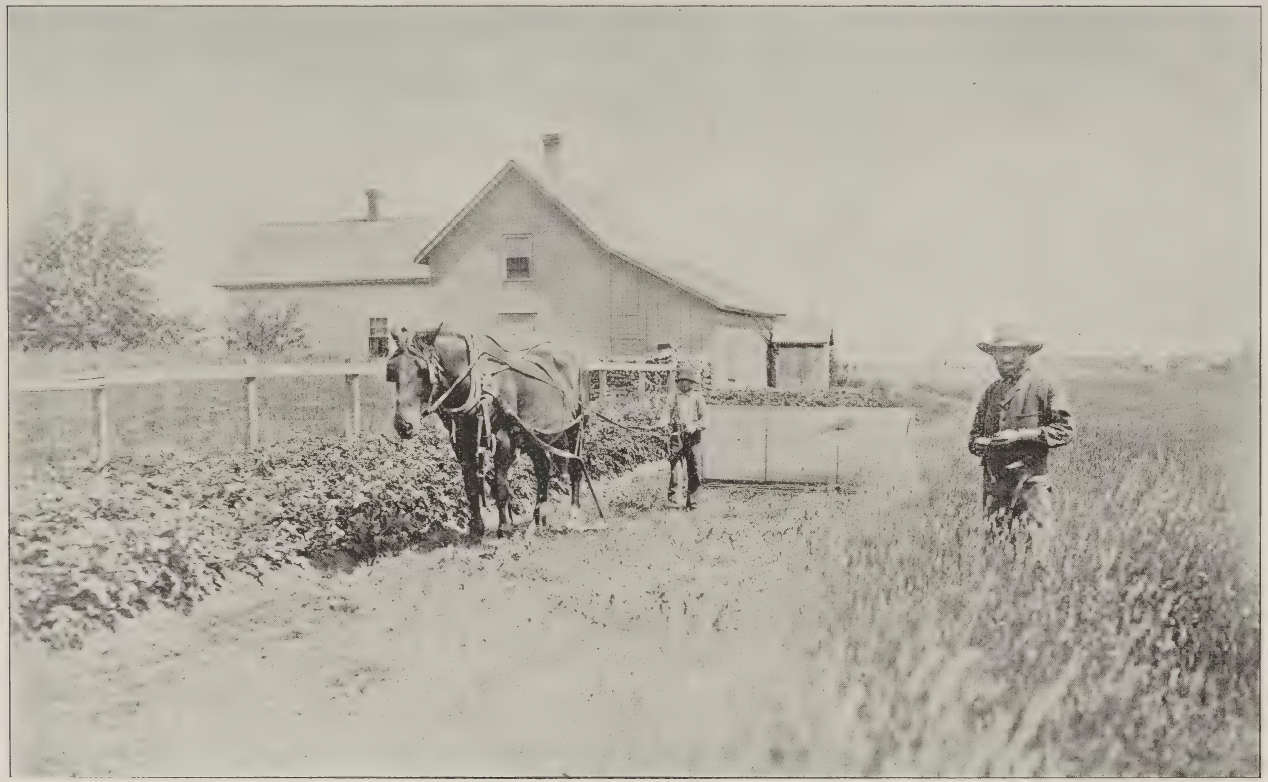

FIG. 30.

PLATE 5.

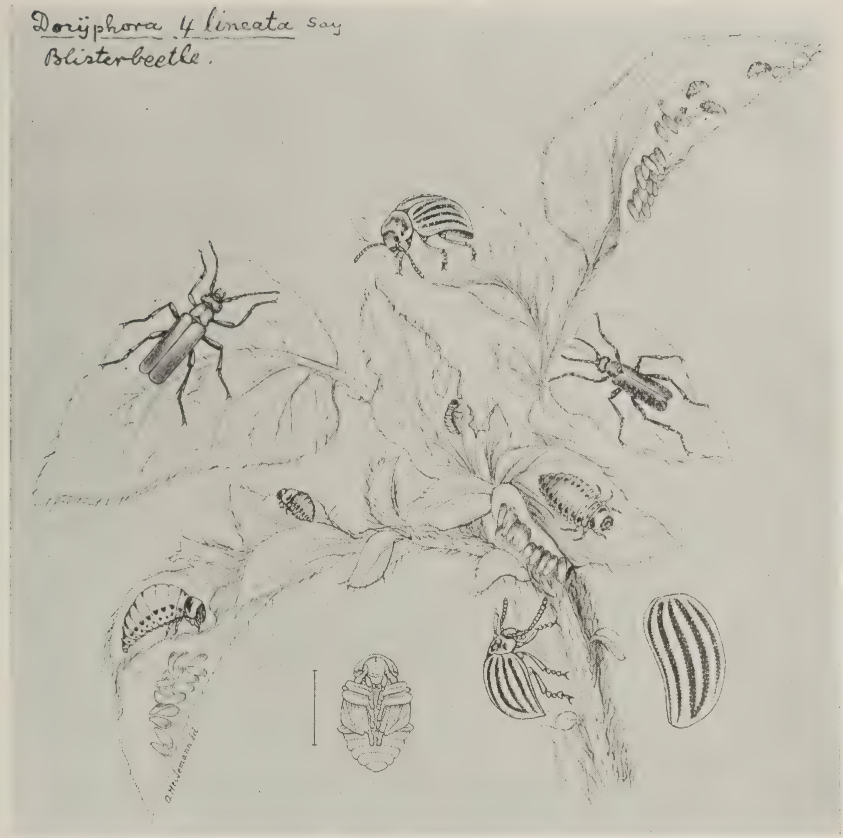

FIG. 36.

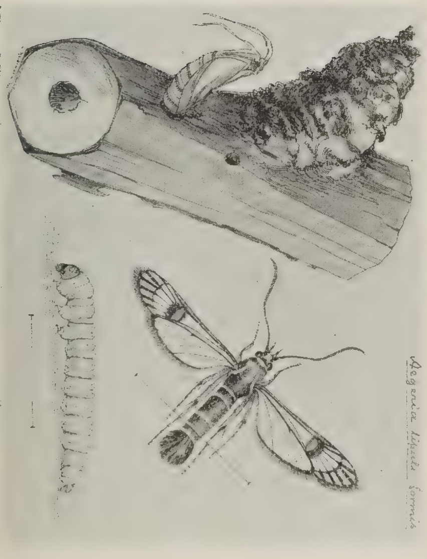

FIG. 45.

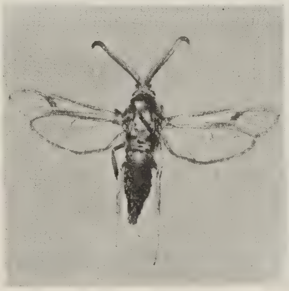

FIG. 51.

PLATE 6.

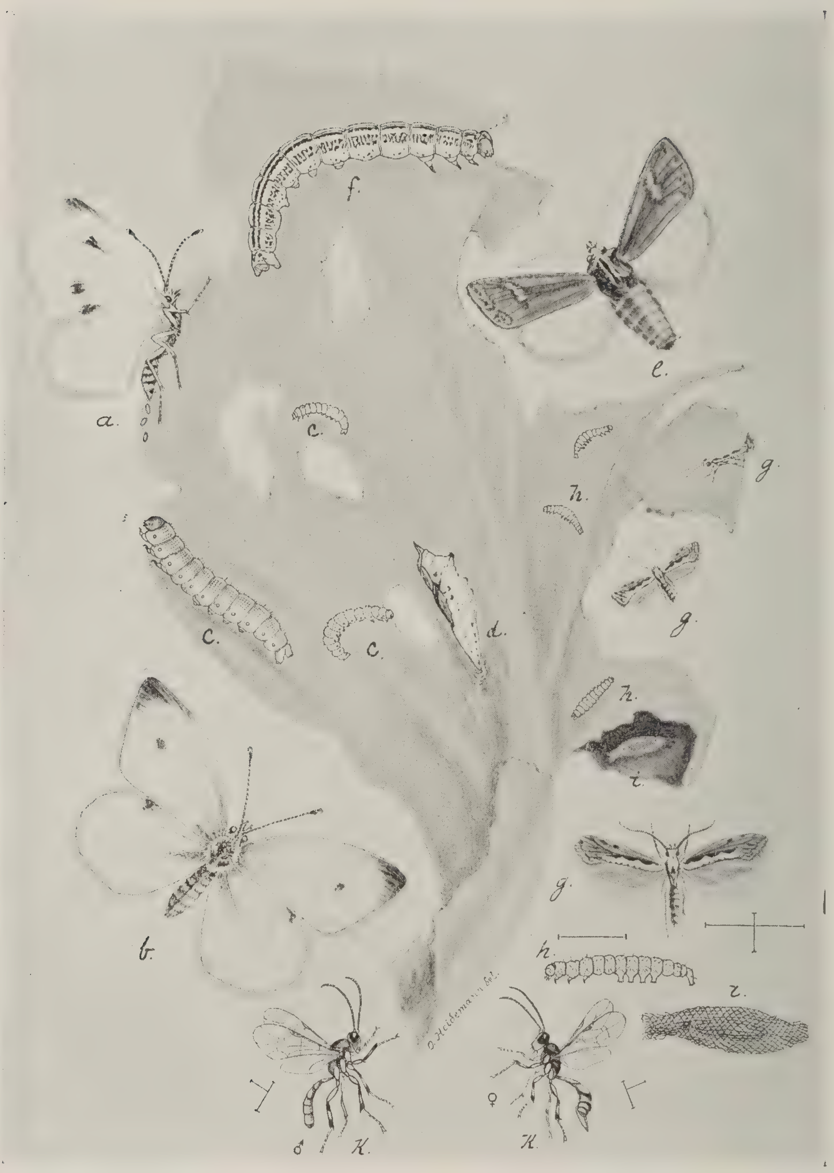

FIG. 37.

PLATE 7.

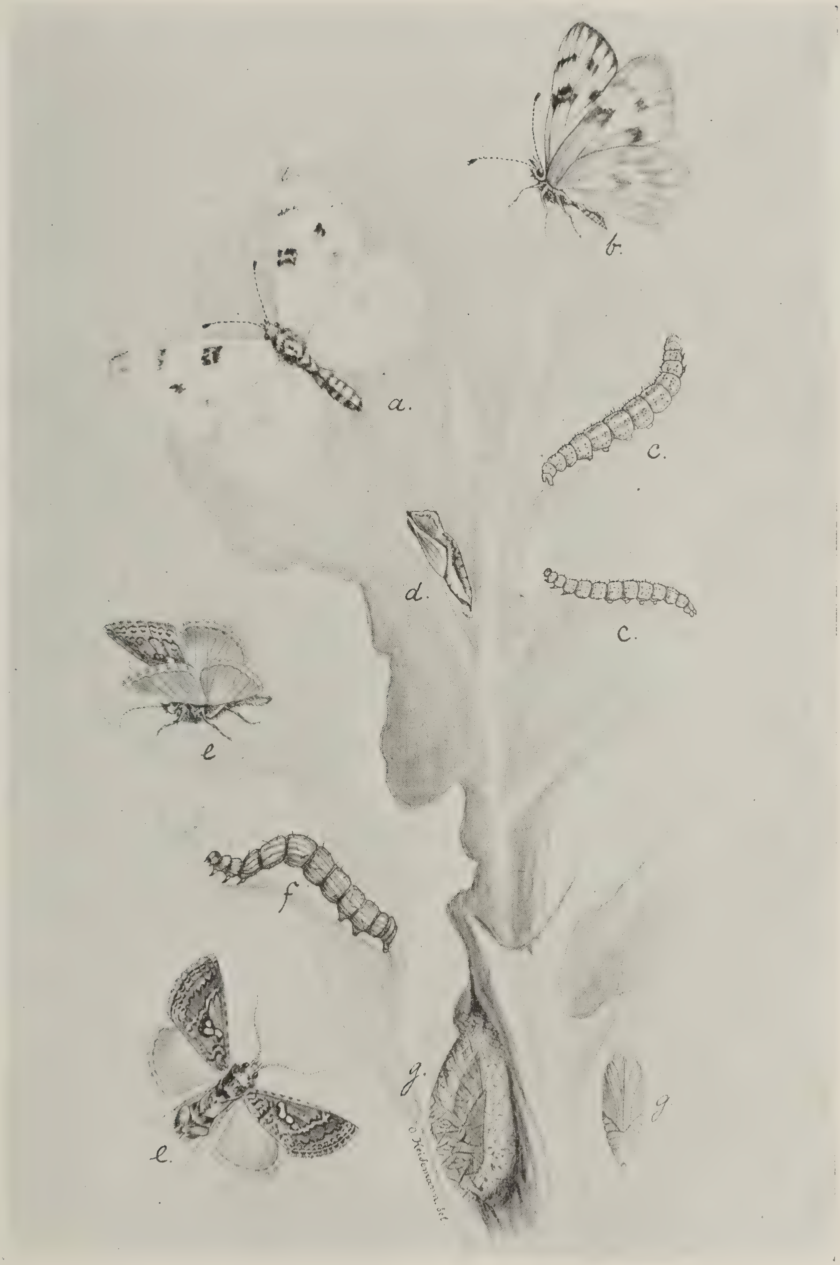

FIG. 38.

PLATE 8.

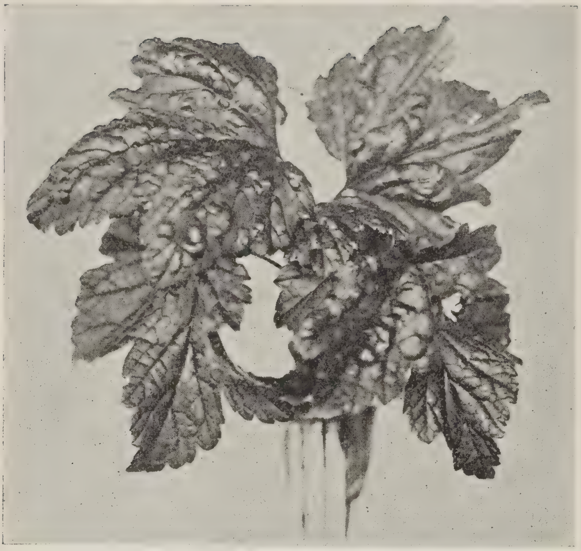

FIG. 42.

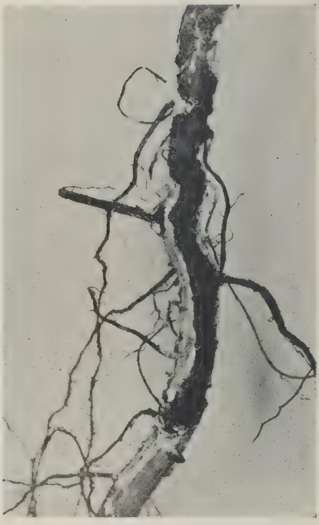

FIG. 47.

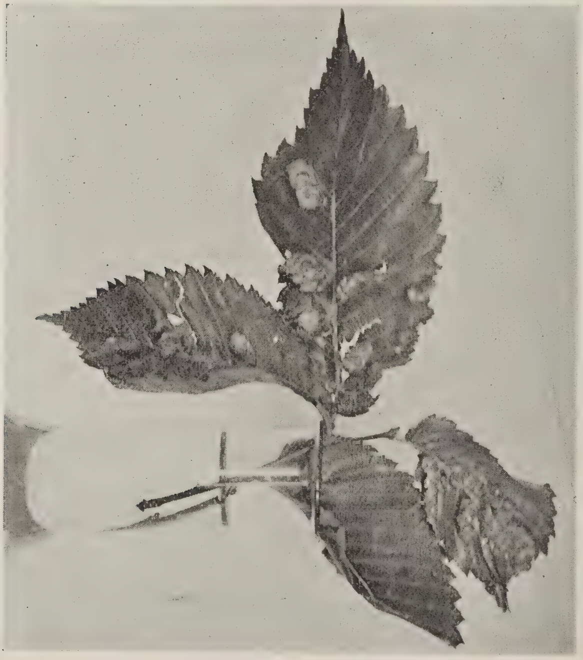

FIG. 63.

PLATE 9.

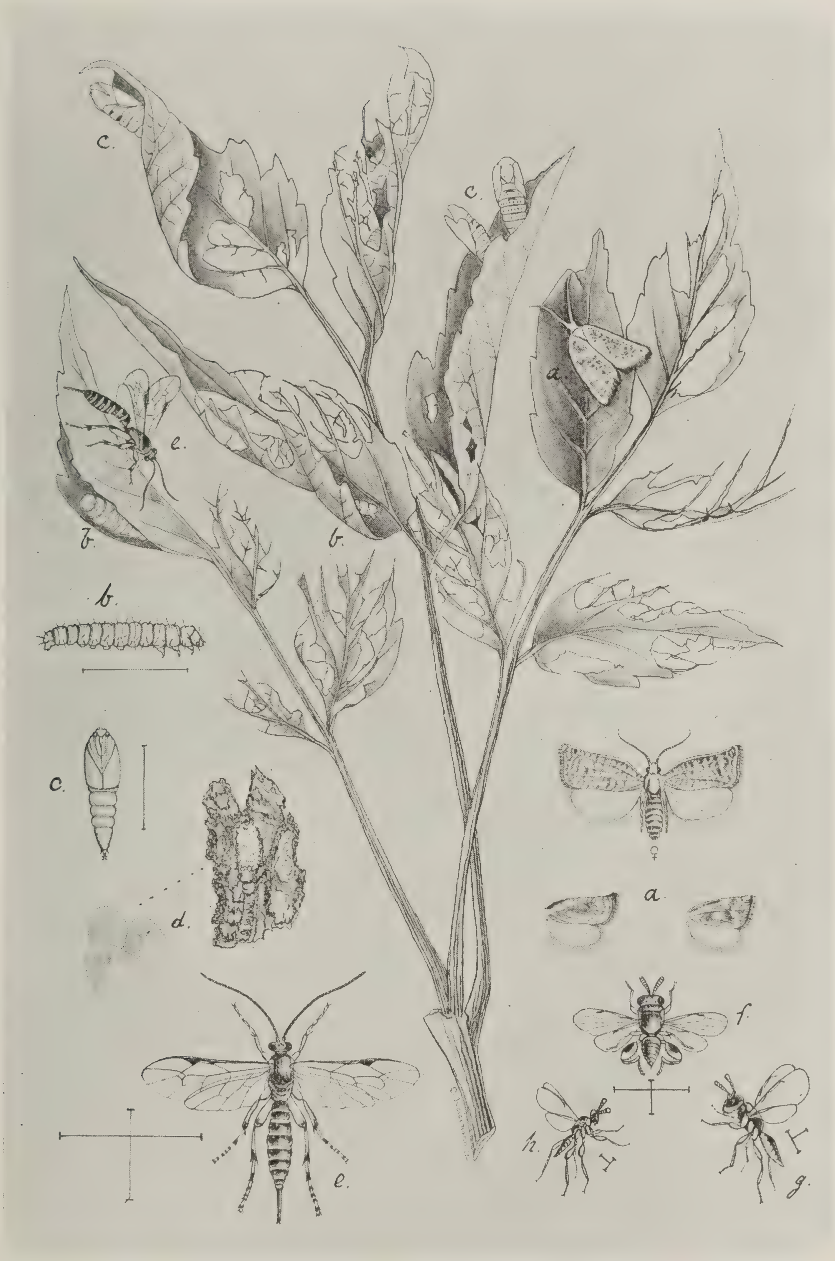

FIG. 52

PLATE 10.

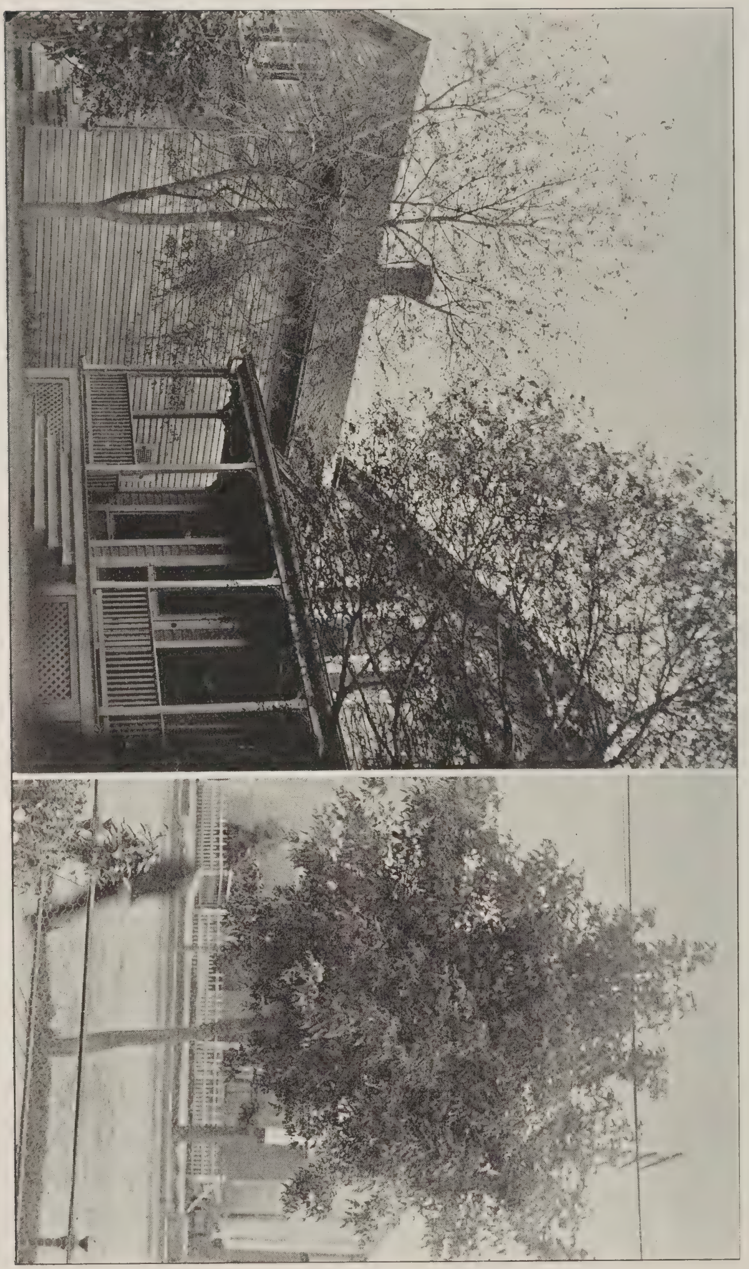

FIG. 53.

PLATE 11.

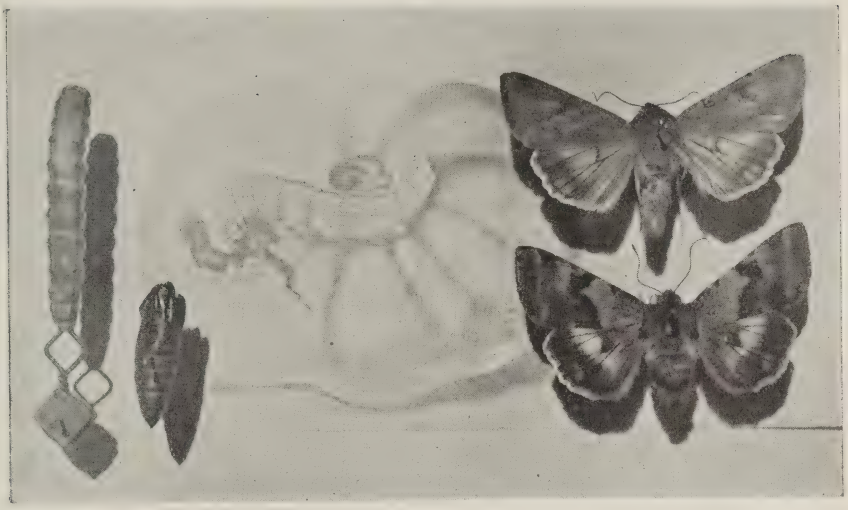

FIG. 54.

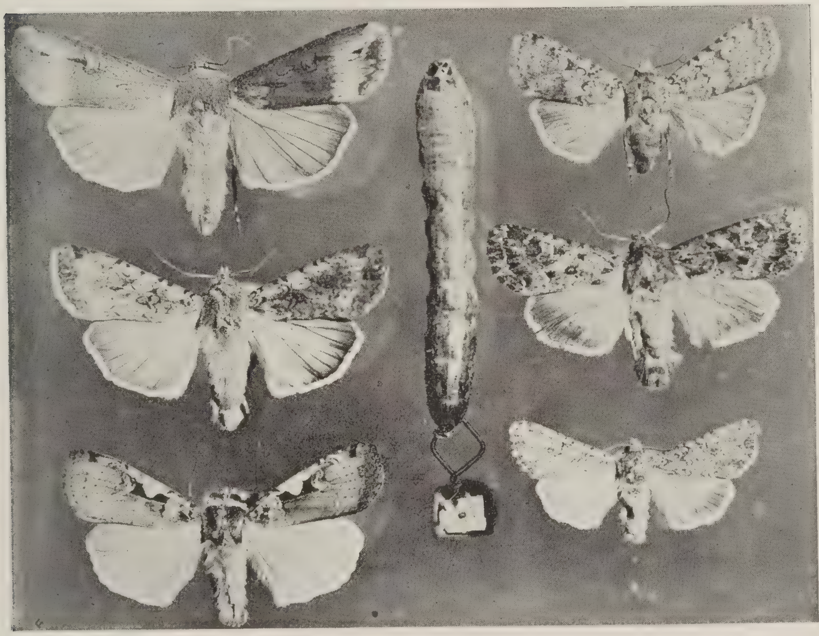

FIG. 76.

PLATE 12.

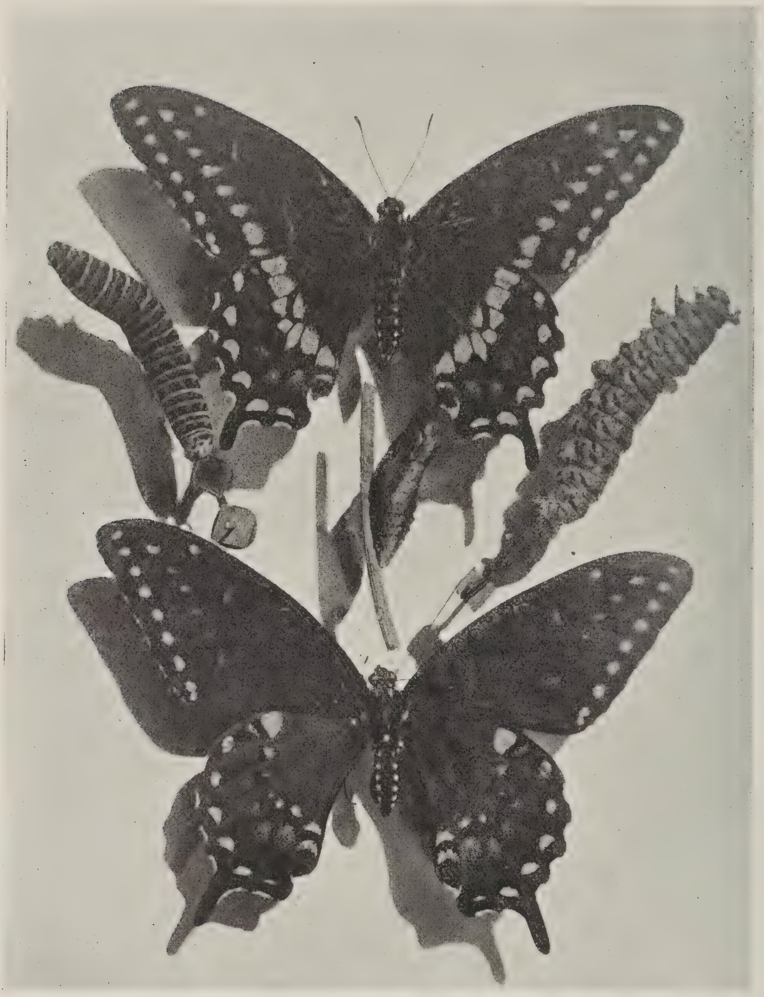

FIG. 55.

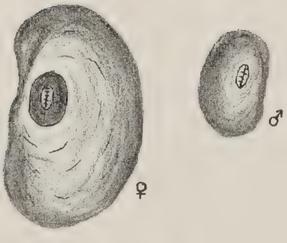

FIG. 68.

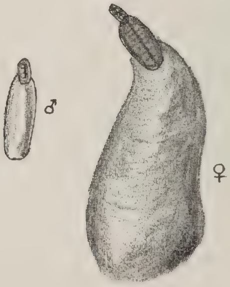

FIG. 69.

PLATE 13.

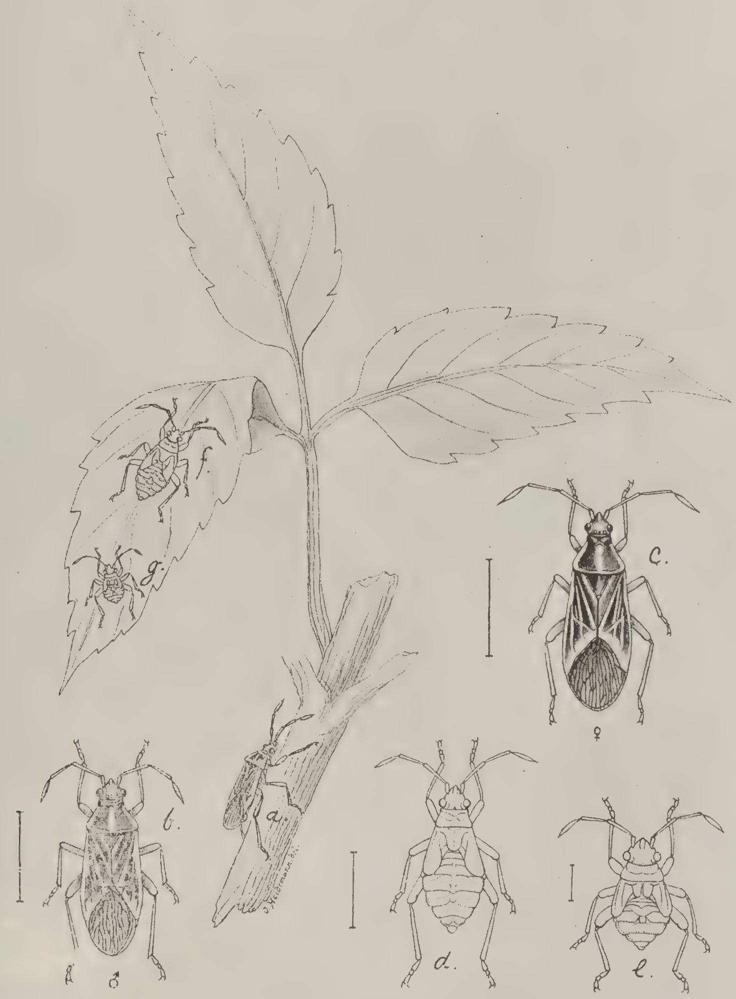

FIG. 57.

PLATE 14.

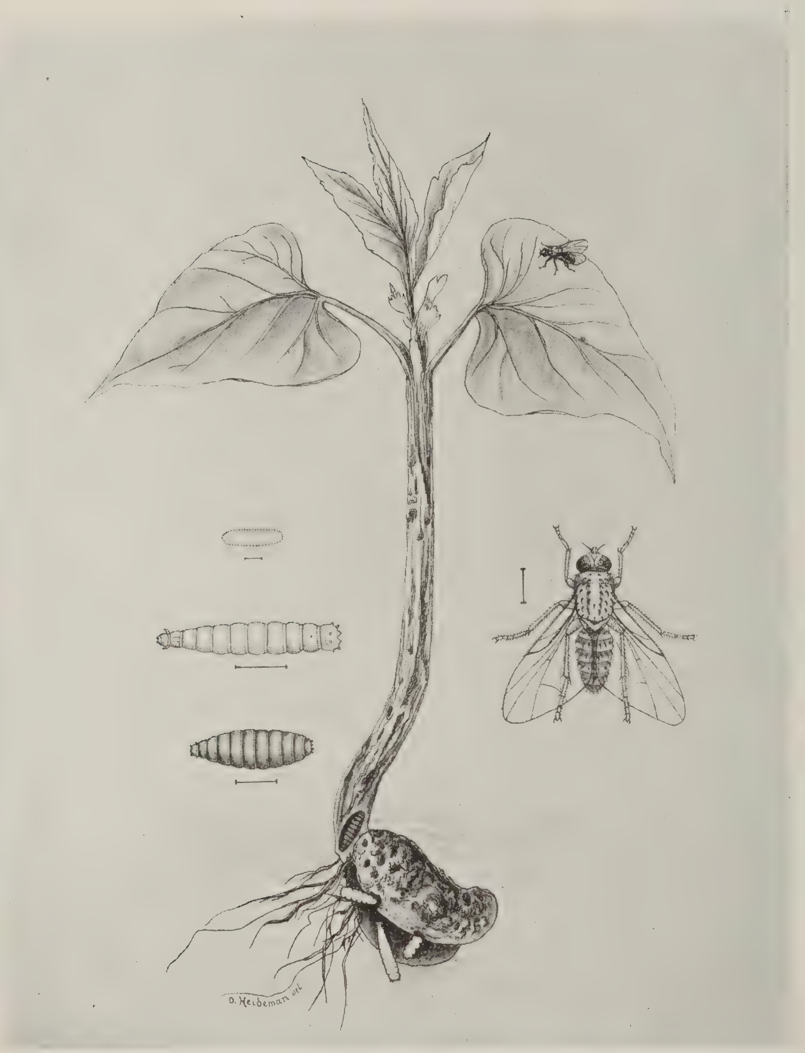
O. Heideman del.

FIG. 58.

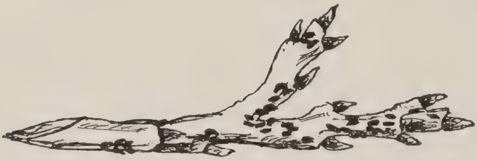

FIG. 62.

PLATE 15.

Wheat fly.

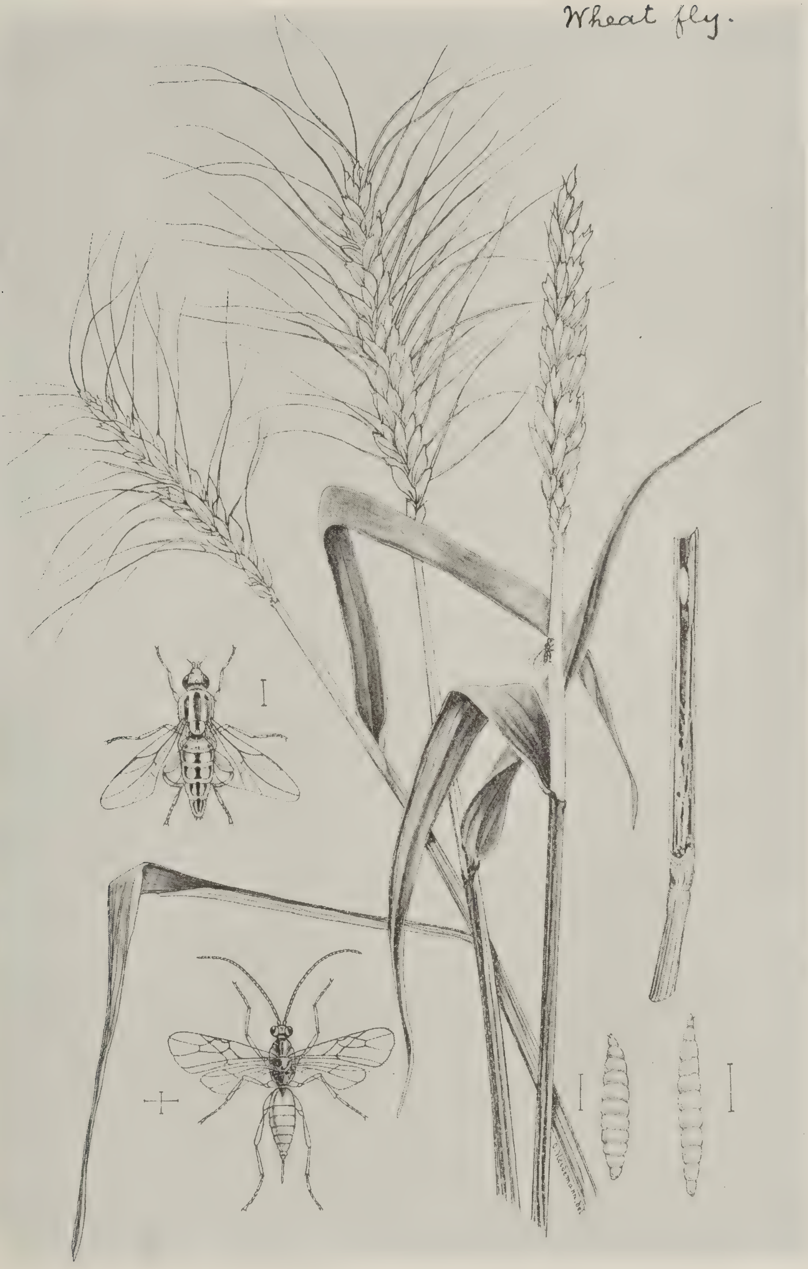
C. Wiedemann del.

FIG. 59.

PLATE 16.

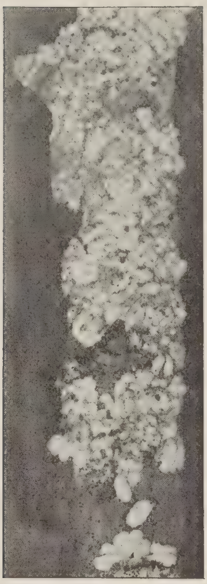

FIG. 66.

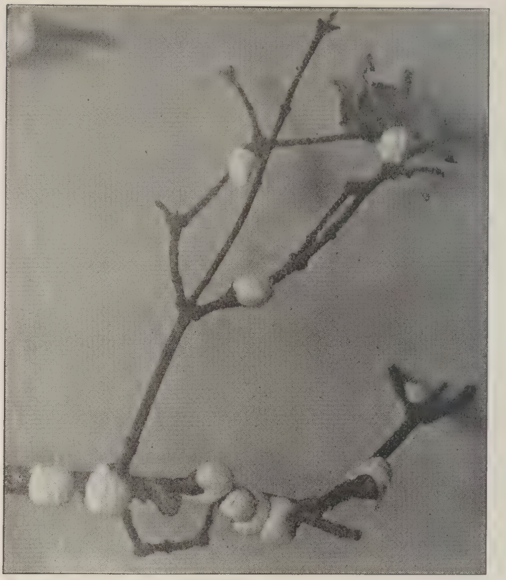

FIG. 65.

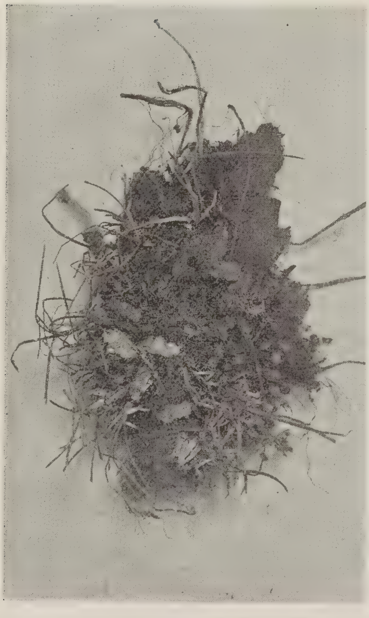

FIG. 28.

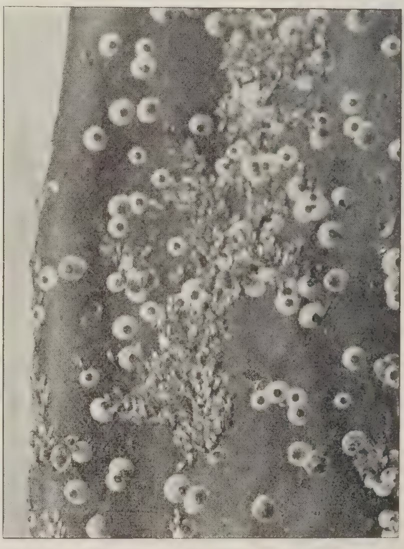

FIG. 67.

INDEX.

Page
Act to provide the entomologist with means, etc....... iii
American Cimbex 82
" Soil Renewer and "Insecticide"........ 29
Analysis of " " " " 29
Anthomyia spec........ 111
Antidotes for arsenical poisoning 68
Ants........ 61
Apanteles glomeratus........ 76
Apanteles of army-worm 77
Aphides 119
Aphis brassicæ........79, 121
" *ribis* 87
Apple-tree leaf-folder........ 100
Application of dry insecticides 136
" " wet " " 131
Ash-gray blister-beetle........ 60
Ash-tree borer 94
Ash-tree louse 121
Aspidiotus ancylus........ 129

Bacterial diseases 9
" " of cabbage worms........ 36
" " of grasshoppers in Colorado 34
" " of tent-caterpillars........ 38
Bag-worm killed by fungus 22
Bark-beetle disease........ 31
Bark-lice 122
Bean-fly 111
Bee-fly 58
Black blister-beetle........ 60
Blister-beetles 59, 68
Bogus insecticide 28
Boll-worm........ 101
Bordeaux mixture 68, 86
Borers—Ash-tree........ 94
" —Currant 88
" —Injuring plum-trees........ 93
" —Lepidopterous 92
" —Red oak........ 93
Box-elder bug........ 108
" " leaf-roller 97
" " louse 121
Bran mash........ 54
Buhach........ 76
Cabbage aphis........79, 121
" butterfly—Imported 71
" " —Native........ 71

Page
Cabbage flea-beetles........ 79
" lice........ 79
" insects........ 70
" Plusia........ 78
" Plutella........ 79
" Zebra caterpillar........ 78
Cacœcia semiferana........ 97
" *rosaceana*........ 100
Camnula pellucida........ 40, 48
Cecidomyia destructor........ 117
Chalcis flavipes........ 99
Chinch-bugs........ 103
—Bogus insecticide........ 28
—Damage caused by........ 103
—Different ways of spelling........ 27
—Disease........ 15
—Distribution of spores in 1895........ 23
—Laboratory experiments and experiences........ 20
—Life-history of........ 14
—Map showing distribution........ 26
—Migration of........ 7
—Production of spores on a large scale........ 18
—Remedies........ 7
—Status at present time........ 25
—Vulnerable points........ 5
Chionaspis americana........ 129
" *salicis*........ 128
Cimbex americana........ 82
Cirrospilus flavicinctus........ 99
Clear-wing moths........ 96
Coccidæ........ 123
Cockscomb gall of the elm........ 120
Colorado locusts........ 39
" potato-beetle........ 61
Common mealy-bug........ 126
Cossus centerensis........ 95
Cottonwood galls........ 120
Cottony maple scale........ 127
Creepers........ 73
Currant borer........ 88
" insects........ 83
" louse........ 86
" worms—Imported........ 83
" " —Native........ 85
Cut-worms........ 70
Dactylopius citri........ 126
Damage caused by chinch-bugs........ 3
Diaspis cacti........ 129
Dibrachys clisiocampæ........ 99

Page
Different ways of spelling chinch-bug 27
Digger-wasps 61
Dilution cultures 13
Diseases caused by bacteria............................ 9
" " fungi 9
Diseases of insects.................................... 9
—of the bag-worm 22
— " " bark-beetle 31
— " " cabbage-worms 12, 36
— " " chinch-bug............................ 15
— " " grasshoppers........................... 11, 34
— " " house-fly 9, 10
— " " silk-worms............................. 9, 10
— " " tent-caterpillars........................ 38
— " " wire-worm 12
Distribution of spores in 1895.......................... 23
Doryphora decemlineata................................ 61

Eccentric scale of the elm 129
Eggs of grasshoppers 68
Elm-tree white-scale.................................. 129
Empusa grilli 11
" *muscœ* 10
Enemies of migratory locusts............................ 55
English sparrow....................................... 127
Entomophthora radicans 13
Epicauta cinerea.... 60
" *pennsylvanica*.............................. 60, 68
" *trichrous* 60
Epidemics of insects................................... 12
Erodium cicutarium................................... 105
Experiments with chinch-bug disease 20

Financial report....................................... IV
False caterpillars...................................... 81
Flea-beetles 79
Flesh-fly 58
Flies killed by disease 22
Force-pumps.. 130
Four-lined leaf-bug 87
Fungus diseases of cabbage-worms 9, 12
" " " chinch-bugs....................... 15

Galls on cottonwood.................................... 120
" elm.. 120
" grape-vine................................. 120
Glueckspinnen... 55
Gophers... 61
Grape phylloxera...................................... 120
Grapta butterfly....................................... 87
Grapta comma.. 87

Page
Grasshoppers near Taylor's Falls and elsewhere 50
—The lesser migratory 39
—The pellucid 39
Grindelia squarrosa 104
Ground beetles 61

Hair-snakes 61
Heliothus armiger 100
" *phlogophagus* 104
Hessian-fly 117
Hellebore 85
Honey-dew 121
Honey from honey-dew 122
Hopperdozers 50
Hot water for cabbage-worms 75
House-fly disease 9, 10
Hubbard formula for kerosene-emulsion 122
Hydrocyanic-acid gas 125

Imported cabbage-butterfly 71
" currant worm 83
Infection boxes 21
Insecticides 65, 85, 122
Insect diseases 9
Isaria anisopliæ 12
" *tomicii* 31
" *vexans* 15

Kerosene-emulsion 76

Laboratory experiments and experiences 20
Lady-bugs 103
Lepidopterous borers 22
Leptocorisa trivittata 108
Leaf-roller on apple-tree 100
" " box-elder 97
" " cherry and currants 95
Lesser migratory locust 42
Letter of transmittal II
Lettuce root-louse 120
Life-history of chinch-bug 4
Lime and carbolic-acid powder 76
Limneria tibiator 79
List of owlet moths 142
Locusts—Lesser migratory 39
—Migratory 39
—near Taylor's Falls and elsewhere 50
—Parasitic enemies of 55
—Pellucid 39
—Rocky mountain 55

Macrobasis unicolor 60, 68

Page
Machines for applying insecticides 130
Mamestra picta 78
Map showing distribution of chinch-bugs 27
Maple-tree borer 92
Mason jars for growing spores 19
Mealy-bug 126
Melanoplus atlanis 40, 42
“ *bivittatus* 34
“ *femur-rubrum* 35, 40
“ *spretus* 39
Margined blister-beetle 60
Meromyza americana 114
Migratory locusts or grasshoppers 39
Migration of chinch-bugs 4
Milk of lime 66
Mite of locust—Red 55
Mormon louse 3
Mosquitoes killed by disease 22

Native cabbage-butterfly 71
“ currant-worm 85
Nematus ventricosus 83
Nozzles 134

Orchard gun 136
Oxide of silicates 75
Owlet-moths taken at sugar 142

Papilio asterias 106
Parasitic enemies of locusts 55
Paris green for baits 54, 65, 166
“ “ —Dry application 66
“ “ —Wet “ 66
Parsley butterfly 106
Pebrine 9
Pellucid locust 39
Phylloxera 120
Pieris brassicæ 13
“ *protodice* 70
“ *rapæ* 36, 70
Pimpla inquisitor 99
Plant-lice 119
Plate-cultures 14
Plowing to destroy grasshoppers 49, 54
Plusia brassicæ 78
Plutella cruciferarum 79
Pœcilocapsus lineatus 87
Poisoning grasshoppers 54
Poisonous baits 54, 64, 140
Potato-beetles 61
Potato, sterilized for cultures 15

Page
Powder bellows 136
Prionoxystus querciperda 95
" *robiniæ* 95
Pristiphora grossulariæ 85
Production of spores on a large scale 18
Pteromalus puparum 77
Pulvinaria innumerabilis 127
Pure cultures 13
Pyrethrum 75
Pyrrhia angulata 105
" *umbra* 105

Raupenleim 139
Red-headed blister-beetle 60
Red-legged locust 35, 40
Red mite 55
Red oak borer 93
Remedies against aphids 122
" " bean-fly 113
" " blister-beetles 66
" " box-elder bug 110
" " " leaf-folder 99
" " cabbage-butterflies 73, 74
" " " plutella 79
" " " chinch-bugs 7
" " cottony maple-scale 127
" " currant borer 91
" " currant louse 87
" " " worms 85
" " four-lined leaf-bug 88
" " hessian fly 118
" " mealy bug 126
" " migratory locusts 47
" " parsley butterfly 108
" " potato-beetle 64
" " scale insects 124
" " tassel worm 104
" " wheat-stem maggot 115
" " white scale of cactus 129
" " willow scale 128
" " zebra caterpillar 78
Robber-fly 61
Rocky Mountain locust 39
Rosin wash 125
Rosin-weed caterpillar 104

Sarcophaga carnaria 55
Saw flies 81
Scale insects 123
Sesia tipuliformis 88

Page

Shrews....61, 104
Silk worm disease.... 9
Skunk.... 61, 91
Slugshot.... 75
Slugs.... 81
Snakes.... 61
Soap.... 81, 92
Soil Renewer and Insecticides—American.... 29
Solanum rostratum.... 92
Soldier-beetle.... 91
" bug.... 104
Spanish flies....59, 70
Spelling chinch-bug.... 27
Spores—Distribution of.... 23
" —Production of.... 21
Sporotrichum globuliferum....11, 15, 23, 32
Spraying machines.... 130
Status of chinch-bugs at the present time.... 25
Sterilizers....14, 19
Sugaring.... 141
Swallow-tail butterflies.... 106
Sweet corn moth.... 100
Syrphus-flies.... 80
Systœchus oreas.... 58

Table of contents.... VI
Tachina-fly....41, 99, 103
Tassel worm.... 100
Tent-caterpillar disease.... 38
Thyridopteryx ephemeræformis.... 22
Tomicus disease.... 31
Toads.... 91
Trochilium fraxini.... 94
" *luggeri*.... 93
Trombidium locustarum.... 75

Vulnerable points in the habits of chinch-bugs.... 5

Wheat-stem maggot.... 114
White arsenic.... 67
" hellebore.... 85
" scale of cactus.... 129
" Mountain locust.... 42
Willow scale.... 128
Wire-worm disease.... 12

Zebra caterpillar.... 78

ERRATA.

Page 12, line 18, read spores for pores.
" 16, line 12, read its for it.
" 18, line 13, read 25 mm. for 2.5 mm.
" 19, line 33, read mushrooms for mushroons.
" 20, line 25, read infected for affected.
" 27, line 1, read forest for forets.
" 80, line 13, read aphids for appids.
" 80, line 27, read *Aphidius* for *aphidiust.*
" 122, line 1, read trees for treee.

SECOND ANNUAL REPORT

OF THE

ENTOMOLOGIST

OF THE

State Experiment Station

OF THE

University of Minnesota,

TO THE GOVERNOR,

FOR THE YEAR 1896.

By Otto Lugger,
Prof. of Entomology,
University of Minnesota.

DELANO:
The Eagle Printing Co., Printers.
1896.

LETTER OF TRANSMITTAL.

STATE EXPERIMENT STATION,
UNIVERSITY OF MINNESOTA.
January 1, 1897.

To His Excellency, D. M. Clough, Governor of Minnesota:

SIR—In accordance with the law, I have the honor to present herewith my second annual report as Entomologist of the Experiment Station of the University of Minnesota for the year ending December 31st, 1896.

Very Respectfully,
Your Obedient Servant,
OTTO LUGGER.

FINANCIAL REPORT.

1895.				No. of voucher.	Amount.
Aug.	30.	To	salary and labor during August	1-5	230.00
	21	"	⅛ pound Carb. Potash	6	.20
	30	"	express	7	5.89
	30	"	ice	8	.65
	30	"	illustrations—O. Heidemann	9	55.00
	2	"	postage	10	15.00
	1	"	1 gr. Mimeo. Stencil No. 31	11	1.75
	6	"	trip to Perham	12	7.75
	12	"	hotel and livery	13	15.45
	1	"	2,500 letter-heads and envelopes	14	20.00
	16	"	trip to New Ulm	..	6.20
	19	"	hotel and livery	15	6.50
	2	"	Noyes Brothers & Cutler for insecticides, chemicals, etc	16	16.92
	31	"	telegrams, street-car fare, meals	..	4.70
	30	"	Zimmerman Bros. for process plates	17	4.86
	24	"	O. H. Peck for plates and chemicals	18	9.30
	28	"	Zimmerman Bros. for plates, etc	19	6.95
	16	"	Zimmerman Bros. for plates, etc	20	1.20
	24	"	W. H. Gruenhagen for gasoline	21	1.75
	31	"	Husby Bros. for dark room	22	18.50
	26	"	trip to Taylor's Falls	..	1.35
	28	"	hotel and livery	23	8.50
	30	"	Bailey for stamps ($15.00), telegrams, express, etc	24	19.50
	30	"	G. E. Stechert for books	25	41.32
Sept.	30	"	salary and labor during September	1-3	160.00
	30	"	Minneapolis Photo. Supply Co	4	1.90
	21	"	O. H. Peck for chemicals and plates	5	8.08
	30	"	express	6	4.60
	30	"	Lindig Bros. for meat	7	2.60
	1	"	ice	8	2.00
	14	"	G. E. Stechert for books	9	85.01
	4	"	O. Heidemann for illustrations	10	55.00
	27	"	Zimmerman Bros. for chemicals, plates, etc	11	32.42
	1	"	trip to Taylor's Falls (R. H. Pettit)	12	5.85
	1	"	expenses during August and September (R. H. Pettit)	13	4.80
	1	"	trip to New Ulm	14	8.70
	1	"	trip to Mankato, Windom, Worthington	..	7.75
	1	"	sleeper Worthington to St. Paul	15	1.75
	1	"	street-car fare, telegrams and postage	..	1.95
Oct.	9	"	Zimmerman Bros. for plates and slides	1	16.45
Dec.	1	"	ice	2	2.00
Oct.	18	"	Bausch & Lomb Optical Co. for sterilizer	3	7.50
	31	"	O. Heidemann for illustrations	4	55.00
	1	"	G. E. Stechert for books	5	4.11
	14	"	G. E. Stechert for books	6	13.09
	31	"	M. J. O'Neil for Welsbach burner and stan'rd	7	5.25
Nov.	1	"	salary and labor for October	8-10	142.00
	11	"	O. Heidemann for illustrations	11	55.00
	29	"	Zimmerman Bros. for one pkg. opaque	12	.50
	29	"	W. H. Gruenhagen for tools, screws, etc	13	3.15
	16	"	G. E. Stechert for books	14	4.20
Dec.	1	"	Zimmermann Bros. for plates	15	3.24
	13	"	John Schmitt, for boxes	16	55.00
	6	"	O. H. Peck for two bottles Kloro	17	1.00

1895.				No. of Voucher.	Amount.
Dec.	1	"	New York Entomol. Journal	18	2.00
	1	"	salary and labor for November	19-20	115.00
	1	"	R. H. Pettit for meat, expr., etc	21	3.85
	1	"	express	22	1.60
	1	"	postage	23	5.00
	16	"	J. C. Carbutt for tabloids	1	1.85
	24	"	W. H. Gruenhagen for hardware	2	3.50
	30	"	salary and labor for Dec	3-5	130.00
	30	"	postage	6	5.00
Jan.	2	"	type-writing	7-8	23.00
Dec.	31	"	Art Engraving Co. for illustrations	9	84.00
1896.				No. of Voucher.	Amount.
Jan.	1	"	G. E. Stechert for books	10	18.48
	9	"	O. H. Peck for Karsak paper.	11	1.50
	9	"	blue paper	12	.30
	19	"	Minneapolis Photo. Supply Co. for chemicals, plates, etc	13	33.54
	20	"	C. J. Ross, paper for illustrations	14	4.93
	31	"	salary and labor for Jan. 1896	15-17	130.00
	31	"	R. H. Pettit for express, toning-bath, etc..	18	4.90
	31	"	Thos. Husby for cabinet	19	50.00
	31	"	postage	20	10.00
	31	"	Bausch & Lomb, cabinet for slides	21	7.50
	31	"	express	22	6.50
	31	"	expenses during Oct., Nov., Dec. and Jan.	23	8.65
Feb.	15	"	Harrison & Smith, for printing 1st annual report	..	953.00
	1	"	N. Y. Ent. Jour	1	4.00
	17	"	postage for mailing 1st annual report	2	30.00
Mar.	1	"	salary and labor for Feb	3-5	130.00
	25	"	W. H. Gruenhagen, for incubator	6	12.05
	26	"	Whitall, Tatum & Co. for jars and glassware	7	24.17
	27	"	J. A. Schlener & Co. for stationery	8	16.05
	28	"	J. Guth, for binding books	9	23.95
	31	"	Zimmermann Bros. for plates, tablets, etc.	10	8.90
	31	"	Art Engraving Co. for 24 cuts	11	15.45
	29	"	salary and labor for March	12-14	130.00
April	1	"	typewriting	15	11.80
	1	"	meat, meal, etc	16	4.60
Mar.	8	"	trip to Chicago to entomological meeting.	17	18.50
	8	"	street-car fare	..	2.80
April	8	"	Whitall, Tatum & Co. for jars, etc	1	9.42
	23	"	Bausch & Lomb Optical Co. for microscopic accessories	2	36.98
	23	"	one flange	3	.59
	23	"	Bausch and Lomb Optical Co. for one Zeiss lens	4	20.00
	24	"	L. M. Hart for drawings	5	7.00
	15	"	Noyes Brothers and Cutler for chemicals..	6	5.91
	24	"	G. E. Stechert for books	7	47.12
	24	"	G. E. Stechert for books	8	14.26
	24	"	G. E. Stechert for books	9	4.58
	2	"	W. Menzel & Son for caterpillar lime	10	5.25
	30	"	W. H. Gruenhagen for material for gas machine	11	7.80
	23	"	Zimmermann Bros. for printing paper, etc.	12	5.00
	30	"	Art Engraving Co. for illustrations	13	18.40

1896.				No. of voucher.	Amount.
April	8	“	Gustav Fock for books....................	14	27.25
	18	“	Stevens and Robertson for Ross paper....	15	1.80
	13	“	L. Malchow for pots......................	16	5.59
	30	“	salary and labor for April................	17-20	195.00
	24	“	trip to Rochester..........................	..	11.75
	25	“	G. Hargesheimer & Sons for chemicals....	21	3.50
	30	“	express....................................	22	3.35
	30	“	postage, street-car fare, etc...............	..	3.40
	30	“	W. Boss for photo. micr. stand............	23	5.75
May	2	“	stamps......................................	1	15.00
	19	“	repairing pump............................	2	.65
	20	“	trip of two assistants to Excelsior..........	3	1.50
	21	“	trip to Hinckley...........................	..	6.10
	25	“	W. H. Gruenhagen for jars, etc............	4	9.00
	15	“	W. L. Nott Co. for tubing.	5	1.00
June	1	“	Art Engraving Co. for illustrations.......	6	19.00
May	30	“	Harrison & Smith for circulars and labels	7	25.00
	26	“	Zimmerman Bros. for plates, etc..........	8	2.10
	14-21	“	G. E. Stechert for books..................	9-10	46.40
	21-16	“	G. E. Stechert for books..................	11-12	9.25
	5	“	G. E. Stechert for books..................	13	14.27
	26	“	trip to New Ulm..............................	...	8.30
June	1	“	Lindig Bros. for meal, meat, etc................	14	6.85
	1	“	salary and labor for May........................	15-18	180.00
May	30	“	L. M. Hart for drawings.........................	19	19.00
	30	“	express..	20	2.25
	29	“	trip to New Ulm..............................	1	4.90
June	2	“	Noyes Brothers & Cutler for pill-boxes, etc	2	7.25
	6	“	Hertz Bros. for hose and piston.................	3	4.75
	11	“	Stevens & Robertson for paper and crayons	4	1.71
	13	“	trip to Excelsior..	5	.75
	15	“	trip to Tower..	6	5.70
	17	“	hotel in Tower..	7	4.00
	18	“	hotel in Duluth..	8	3.00
	23	‘	hotel in Perham..	9	4.75
	23	“	trip to North Branch......................................	10	3.98
	30	“	stamps..	11	15.00
July	1	“	Art Engraving Co...	12	31.10
	1	“	salary and labor for June..................................	13-16	365.00
	1	“	express..	17	.55
	1	“	street-car fare, tele., boat, sleeper, bus, etc.	...	9.00
	8	“	postage stamps..	1	15.00
	2	“	L. M. Hart for drawings..................................	2	6.00
June	4	“	G. E. Stechert for books..................................	3	3.75
	30	“	G. E. Stechert for books..................................	4	.50
May	26	“	G. E. Stechert for books..................................	5	6.08
April	6	“	G. E. Stechert for books..................................	6	4.00
July	10	“	Otto Heidemann for illustrations.....................	7	55.00
May	29	“	Bausch & Lomb Optical Co. for objectives	8	24.75
June	4	“	Zimmerman Bros. for slides............................	9	1.10
July	30	“	Art Engraving Co. for cuts..............................	10	24.50
	31	“	W. H. Gruenhagen for hardware.....................	11	9.10
	31	“	Lindig Bros. for meat, meal, etc......................	12	2.44
	18	“	express..	13	4.15
	31	“	salary and labor for July.................................	14-17	265.00
	31	“	trips of R. H. Pettit..	18	11.82
					$4,985.51

TABLE OF CONTENTS.

Page.

Letter of transmittal II

Financial report III

Table of contents VI

Introduction 1

Insects injurious in 1896 3

The Chinch-bug in 1896 3

The Frit-fly (*Oscinis soror* Macq.) 6

The Wheat-stem Maggot (*Meromyza americana* Fitch) 10

The Hessian-fly (*Cecidomyia destructor* Say) 11

The Army-worm (*Leucania unipuncta* Harv.) 14

The Erratic Army-worm (*Noctua fennica* Tausch) 20

The White-grubs (*Lachnosterna tristis* Fab. and *L. rugosa* Melsh.) 22

The Common Hairy Rose-beetle (*Euphoria inda* Linn.) 26

The Potato-beetle (*Doryphora decemlineata* Say) 27

The Domestic Cricket (*Grillus domesticus* Linn.) 28

The Box-elder Leaf-roller (*Cacœcia semiferana* Walk.) in 1896 31

The Grape-vine Leaf-hoppers (*Typhlocyba spec.*) 33

Report of Mr. R. H. Pettit 34

The Celery Tree-hopper (*Cicadula 4-lineata* Forbes) 37

The Lilac-borer (*Sesia syringæ* Harr.) 38

The Plum-gouger (*Coccotorus prunicida* Walsh) 38

The Plum-curculio (*Conotrachelus nenumphar* Hbst.) 41

Parasites of Man and Domesticated Animals 44

Introduction 44

I. External Parasites. (*Epizoa*) 46

A. Face-mites. Black-heads. (*Demodecidæ*) 46

Face-mite of Man (*Demodex folliculorum* Sim.) 48

Demodex of the Dog (*D. folliculorum* var. *canis*) 48

Demodex of the Cat (*D. folliculorum* var. *cati*) 48

Demodex of the Hog (*D. phylloides suis*) 48

Remedies 49

B. Itch-mites. (*Sarcoptidæ*) 50

1. Burrowing Mites. (*Sarcoptes*) 52

Itch-mite of Man (*Sarcoptes scabiei* De. G. var. *hominis*) 54

Remedies 56

Norwegian Itch-mite of Man (*Sarcoptes crustosæ* Fuerst) 58

Scab of Hog or the Scale-bearing Itch-mite (*Sarcoptes scabiei* var. *suis*) 58
Mange of the Horse (*Sarcoptes scabiei* var. *equi*) 59
Remedies 60
Head-scab of the Sheep (*Sarcoptes scabiei* var. *ovis*) 60
Remedies 60
Mange of the Dog (*Sarcoptes scabiei* var. *canis*) 61
The Small Itch-mite (*Sarcoptes minor* Fuerst) 61
Remedies 62
The Chicken-scab (*Sarcoptes mutans* Rob. or *Knemidokoptes viviparus* Fuerst) 63
Remedies 64
2. Skin-eating Itch-mites. (*Psoroptes*) 64
The Common Mange of the Horse (*Psoroptes communis* var. *equi* 65
The Mange of the Ox (*Psoroptes communis* var. *bovis*) 66
Remedies 66
The Common Sheep-scab (*Psoroptes communis* var. *ovis*) 66
Remedies 71
3. Sucking Itch-mites. (*Symbiotes*) (*Chorioptes*) 75
The Foot-mange of the Horse (*Symbiotes communis* var. *equi*) 76
The Foot-scab of the Sheep (*Symbiotes communis* var. *ovis*) 76
The Ear Itch-mite of the Dog (*Symbiotes auricularum* var. *canis*) 77
Remedies 77
Bird-mites 78
C. Harvest-bugs. Jiggers. (*Trombidiidæ*) 80
The American Harvest-mite (*Leptus americanus* Ril.) 82
The Irritating Harvest-mite (*Leptus irritans* Ril.) 82
The Harvest-bug of Europe (*Leptus autumnalis* Shaw) 83
D. Gamasids. (*Gamasidæ*) 84
The Chicken-mite or "Tick" (*Dermanyssus gallinæ* Redi.) 85
Remedies 86
Other mites 87
E. Ticks. (*Ixodidæ*) 89
The Cattle-tick (*Boophilus bovis* Ril.) 91
Remedies 92
The Common Tick (*Dermacentor americanus* L.) 92
F. Sucking-lice. (*Pediculi*) 94
The Head-louse of Man (*Pediculis capitis* DeGeer) 97
The Body-louse of Man (*Pediculus vestimenti* Leach) 99
The Crab-louse (*Phthirius inguinalis* or *pubis* Leach) 100
The Hog-louse (*Hæmatopinus urius* Nitzsch) 101
The Horse-louse (*Hæmatopinus asini* Linn.) 102

The Short-nosed Cattle-louse (*Hœmatopinus eurysternus* Nitzsch) 102
The Long-nosed Cattle-louse (*Hœmatopinus vituli* Linn.) 104
The Goat-louse (*Hœmatopinus stenopsis* Burm.) 104
The Sheep-louse (*Hœmatopinus ovis* n. sp.) 105
The Dog-louse (*Hœmatopinus piliferus* Burm.) 106
Remedies 106
G. Feather- or Hair-lice. (*Mallophaga*) 108
The Biting-louse of the Dog (*Trichodectes latus* Nitzsch) 110
The Biting-louse of the Cat (*Trichodectes subrostratus* Nitzsch) 111
The Biting-louse of the Sheep (*Trichodectes sphærocephalus* Nitzsch) 111
The Biting-louse of the Cattle (*Trichodectes scalaris* Nitzsch) 113
The Biting-louse of the Horse and Ass (*Trichodectes pilosus* Giebel 113
The Biting-louse of the Horse (*Trichodectes parumpilosus* Piaget) 114
The Biting-lice of the Goat (*Trichodectes limbatus* and *climax*) 115

Feather-lice infesting Chickens.

Goniocotes hologaster Nitzsch 118
Goniocotes abdominalis Piaget 118
Goniocotes burnettii Pack 119
Goniodes dissimilis Nitzsch 119
Lipeurus heterographus Nitzsch 120
Lipeurus variabilis Nitzsch 120
Menopon pallidum Nitzsch 120

Feather-lice of Ducks, Geese and Swans.

Docophorus icterodes Nitzsch 121
Docophorus cygni Denny 122
Lipeurus tadornæ Denny 122
Lipeurus squalidus Nitzsch 122
Lipeurus anseris Gurlt 123
Lipeurus jejunus Nitzsch 123
Ornithobius cygni Denny 123
Trinotum luridum Nitzsch 124
Trinotum conspurcatum Nitzsch 124
Trinotum lituratum Nitzsch 124
Trinotum spec. 125

Feather-lice infesting the Pigeon.

Goniocotes compar Nitzsch 125
Goniodes damicornis Nitzsch 126
Goniodes minor Piaget 126
Lipeurus baculus Nitzsch 126
Colpocephalum longicaudum Nitzsch 127

Feather-lice of Peacock, Guinea-fowl and Turkey.

Goniocotes rectangulatus Nitzsch 127
Goniodes falcicornis Nitzsch 127
Goniodes numidianus Denny 128
Goniodes stylifer Nitzsch 128
Lipeurus numidæ Denny 129
Lipeurus polytarpezius Nitzsch 129
Menopon phæstomum Nitzsch 129
Menopon numidæ G. 129

H. Fleas. (*Siphonaptera, Pulicidæ*) 129
Human Flea (*Pulex irritans* Linn.) 130
Dog and Cat-flea (*Pulex serraticeps* Gerv.) 133
Sand-flea (*Sarcopsylla penetrans* L.) 135
Hen-flea (*Sarcopsylla gallinacea* Westwood) 137
Other Fleas 138

I. Louse-flies. (*Hippoboscidæ, Pupipara*) 139
The Sheep-tick (*Melophagus ovinus* Linn.) 141
The Horse-tick (*Hippobosca equina* Linn.) 143

J. Other flies. (*Diptera*) 145
The Common House-fly (*Musca domestica* Linn.) 145
The Blow-fly (*Sarcophaga carnaria* Linn.) 155
The Screw-worm (*Campsomyia* (*Lucilia*) *macellaria* Fab.) 158
The Stable-fly (*Stomoxys calcitrans* Linn.) 160
The Tsetse-fly (*Glossina morsitans*) 161
The Blue-bottle fly (*Calliphora vomitoria* L.) 162
The Horn-fiy (*Hæmatobia serrata* R. Desv.) 162
Gad-flies or Breeze-flies. (*Tabanidæ*) 166
The Blood-sucking Oscinis (*Oscinis pallipes* Loew) 170
The "No-see-um" or "Punkie" (*Ceratopogon* sp.) 171
Buffalo-gnats or Black-flies. (*Simulidæ*) 172
Mosquitoes. (*Culicidæ*) 182

L. Bugs. (*Hemiptera*) 195
The Bed-bug (*Acanthia lectularia* L.) 196
The Water Boatman (*Notonecta undulata* Say) 202
The Electric-Light Bug (*Benacus griseus* Say) 203
Lopidea media Say 203

M. Other Insects 204

II. Internal Parasites. (*Entozoa*) 207

A. Five-mouths. (*Linguatulidæ*) 207
The Tape-worm-shaped Five-mouth (*Linguatula tænioides*) 208

B. Bot-flies. (*Œstridæ*) 209
The Common Bot-fly (*Gastrophilus equi* Fab.) 212
The Red-tailed Bot-fly (*Gastrophilus hæmorrhoidalis* L.) 216

The Nasal Bot-fly (*Gastrophilus nasalis* L.) 217
    Remedies 218
The Sheep Gad-fly (*Œstrus ovis* L.) 219
The Ox Warble-fly (*Hypoderma bovis* De Geer) 226
The Striped Warble-fly or Heel-fly (*H. lineata* Villers) 226
    Remedies 226
Other Bot-flies. (*Cuterebra*) 227
Snow-fly (*Chionea valga* Harr.) 230

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INTRODUCTION.

The second annual report of the entomologist of the State Experiment Station of the University of Minnesota respectfully submitted to his Excellency, Governor D. M. Clough, contains an account of some of the work performed during the year 1896. Other work only commenced or partly finished will be submitted later.

There remains for the entomologist the pleasant duty of expressing his sincere thanks to all persons that have aided him in his work but especially so his assistant, Mr. Rufus H. Pettit, who has assisted faithfully in both the laboratory work and the preparation of this report. Most of the illustrations in it were made by him. Especial thanks are also due to the different newspapers, who with unfailing courtesy published all articles written for the instruction of the farmers in regions infested by injurious insects. The Chicago, St. Paul, Minneapolis and Omaha, the Great Western, the St. Paul and Duluth, and the Northern Pacific R. R. Companies also deserve thanks for their liberality in furnishing free transportation over their roads whenever such was asked.

INSECTS INJURIOUS IN 1896.

OTTO LUGGER

THE CHINCH-BUG IN 1896.

During the early part of the year 1896 but comparatively few chinch-bugs could be found in our state, and owing to the general wet spring many of those that had wintered over successfully became infected with a disease and died. This happy condition did not, however, prevail everywhere, and some of the counties along the Mississippi and Minnesota rivers started with a fairly large number of these pests. Whether it is a coincidence or not one thing became very apparent: wherever large numbers of the disease-spores had been scattered during 1895, few chinch-bugs survived autumn, winter and spring; and in some localities, where the bugs had been exceedingly numerous before, but few, if any, could be found early in 1896. Numerous letters that were received from farmers living in such localities plainly proved that the bugs had gone, had been killed by a disease, and on that account fewer boxes with disease-spores were asked for in such places than the entomologist would have been glad to distribute, if only to make assurance doubly sure. It is a very unfortunate fact that if farmers do not actually suffer losses caused by insects they will not apply remedies against the few they know to be in their fields, simply because these can not cause any great damage; they do not bear in mind the wonderful fecundity of their enemies and how rapidly they can multiply again and overrun their fields. It is this fact that, among other things, has assisted the destructive potato beetle in 1896, and enabled it to multiply so that next year it will again become numerous enough in many fields to cause losses. It would be wrong, however, to claim that farmers alone did not take time by the forelock; we all are apt to neglect precautions, and later have to suffer the consequences.

The climatic conditions of the season of 1896 were such that the chinch-bug disease worked to the satisfaction of all who tried it conscientiously, and if it had been more generally employed in all infested counties, a chinch-bug plague could have been prevented for a great number of years, as most of the few found in our fields could have been killed.

Soon after the abundant spring rains had ceased, and the soil had become dry and warm, a continuous southern wind set in, and this wind brought with it large numbers of chinch-bugs. In some cases it actually "rained" chinch-bugs, and in this manner many localities became again infested. With normal weather the first generation of these insects could not, however, become numerous enough to cause any serious losses to the small grains. A circular sent out at this time awoke many farmers to the fact that spores of the chinch-bug disease could be had free of charge, mailed to their post-office, simply for the asking; and numerous boxes were mailed in consequence. Where the contents of these boxes were used according to the directions and thoroughly applied, success followed; at least many letters received at that time so stated, and it was too bad that many more farmers did not at least try this remedy. Of course those that expected success by simply putting a pinch of such spores here and there in their fields did not succeed, nor did they deserve to do so. No one can expect success who does not diligently and intelligently work for it! As long as there was a fair amount of moisture in the soil, just so long the introduction of disease-spores proved a success; but as soon as our dry summer commenced the disease spread only in exceptional cases, and so slowly as to do but little good. The continuous dry weather assisted the chinch-bugs very materially, though they caused but very little injury to the small grains, with the exception of a few localities especially favorable to these sun-and-heat-loving insects. In some places the corn was invaded and suffered more or less. As the autumn of 1896 was also a remarkably dry one, everything was in favor of the chinch-bug, and consequently large numbers are now with us snugly hidden in such shelters in which they spend the winter.

The counties that suffered most from the insects were Dakota, Goodhue, Wabasha, Winona and Scott, all, with the exception of Scott county, located in the Mississippi valley. Two boxes of spores, with instructions, were mailed to each applicant and the following table shows how many farmers applied for them in different counties:

Blue Earth county	16	farmers.
Brown county	62	"
Carver county	11	"
Chisago county	14	"
Dakota county	194	"
Dodge county	14	"
Douglas county	8	"
Fillmore county	32	"
Goodhue county	56	"
Hennepin county	36	"
Le Sueur county	21	"
Norman county	7	"
Olmstead county	27	"
Rice county	37	"
Steele county	8	"
Scott county	113	"
Wabasha county	238	"
Washington county	152	"
Winona county	187	"
Total	1,233	

Farmers living not too far from the State Experiment Farm called there and received large jars or boxes filled with spores, and many owners of mills and of drug-stores also obtained spores in bulk, so that they could distribute them among farmers living in their neighborhood. Owing to the liberality of the state, very large numbers of such spores can be produced very rapidly, and there is now no excuse for not trying this remedy on a fairly large scale. The spores were grown as in 1895 in glass jars upon a mixture of sterilized corn-meal and beef-tea. As long as fresh these spores are very active, but they can not be kept over winter without losing their vitality. This was disclosed by a number of experiments. The jars containing such spores were kept over winter in warm rooms, cold rooms, and out of doors; in either case the spores could not be made to germinate in spring, and only those that were taken from the bugs killed by the disease could be successfully utilized to start fresh cultures.

The question is often asked: does this fungus, the spores of which are distributed, always kill the bugs? The more the writer and his assistant have worked with this plant the less do they feel satisfied with it as a remedy upon which we can depend. No doubt immense numbers of chinch-bugs are covered with the fungus in the fields where the disease is found, but the question naturally arises: does the disease kill healthy bugs or only those that are already feeble and that would die whether the disease was present or not? Notwithstanding the many very favorable reports received from farmers that have used the spores it remains still an open question whether it is not after all safer to use the other remedies proposed in the First Annual Report than to depend entirely upon the introduction of spores.

Fig. 1 (plate I) shows this injurious insect in its different stages of growth. A single egg is shown in *a*, as well as others upon the roots and upon a lower leaf. In *b* is shown the very young bug, and in *c*, *d*, and *e* the later stages, while *f* shows the adult and mature insect. All the figures are enlarged; their natural size is indicated, however, by the hair-lines near them, and bugs, natural size, are also shown upon the stems of the infested plant.

THE FRIT-FLY.

(*Oscinis soror* Macq.).

During the summer and early part of the fall numerous letters were received from many parts of the state, in which the writers complained about minute worms which infested the stems of wheat just above a joint from three to four inches above the ground. The specimens received at the same time showed that, as a general rule, the first and second joints of the plant were infested. Some farmers complained that their crop of wheat was thus very materially reduced. The plants harboring these worms did not indicate their presence until flowering time, but as soon as the head began to form, the stem above the injured joint wilted, turned yellowish and soon broke down entirely by bending over the infested spot. All sorts of explanations were given at the time, such as too rapid growth of the plant on account of excess of moisture in spring, lack of strength in the stem, a blistering hot sun, and numerous other ones. But when the infested stems were investigated it was found that the worm had weakened them to such an extent, that when the head was formed the plant became top-heavy, and broke down at the weakest spot from force of gravity. This breaking down was not observed by most farmers, but the damage became visible after the grain had been cut and removed, when very many heads of wheat were found upon the ground, which had broken down before harvest, and which consequently were not cut by the reaper. These heads were either entirely empty or filled with berries more or less badly shrunken. The bent or partly broken stems were as a general rule still adhering to the lower portion of the plant. This bending or breaking had taken place most frequently above a node or joint about three inches from the ground. Just below this breakage, and immediately above the joint, the culprits were found. In most cases but one puparium, but in a few cases two, three, or even more puparia could be detected. Such a puparium (fig. 2, *c*) is the contracted and hardened skin of the larva or worm; it is of a glossy chestnut-brown color,

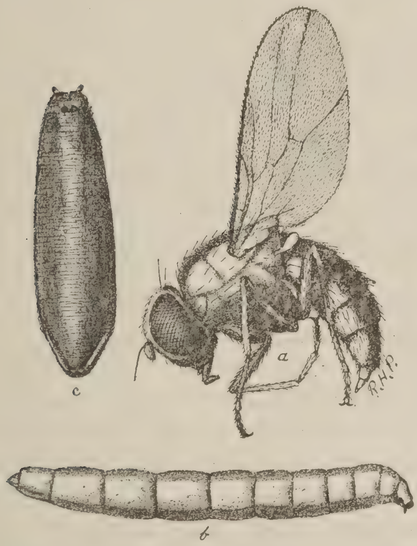

Fig. 2.—Frit-fly: *a*, adult fly; *b*, larva or maggot; *c*, puparium. Greatly enlarged, the mark under fly indicating natural size. Original.

shading to yellowish-brown toward the smaller end. If closely inspected it shows faint traces of sutures or segments. The illustration (fig. 2) shows the different stages of the insect far better than words can describe them. These seed-like objects contain at this time (Oct.) whitish larvæ, or worms; and no pupæ have been detected inside of them up to this date. The larva, or worm, is also illustrated in fig. 2, *b*; it is of a greenish-white color when alive and just removed from the culm.

These puparia are very similar to those of the Hessian-fly in its "flax-seed stage" and their resemblance has given color to the belief that this injurious insect had found a home with us, which unfortunately proved true, as will be shown later. Judging from the fact that only pupæ can be found at this time it would appear as if this insect hibernates in that stage. This is really the only one in which it could well pass our northern winters, being in that stage well protected by its old and thickened skin and by the stem of the plant. The puparia are inserted in the material of the upper part of the node, inaccessible to any moisture from the outside, as the stem above does not break off entirely but simply bends in a more or less acute angle a short distance over them, thus preventing the entrance of water. Yet the culm is sufficiently fractured to permit a free exit of the future fly in spring.

As shown in the following question from Bulletin No. 23, the insect is not an entire stranger in Minnesota: "It is not always easy or even possible to explain why any one insect should suddenly appear in large numbers over an extended area. It is only by a very careful and long continued investigation that we may sometimes arrive at a true explanation. Here it is readily found in the fact that owing to the wet autumn of 1891, and the equally wet spring of 1892, not much more than one-half of the usual acreage of wheat was plowed, and in many places the shocks of grain had to be left upon the fields. Many inquiries plainly indicated that in 1891 small patches of wheat had been noticed which showed bleached heads long before harvest, and no doubt these white culms harbored the insect unnoticed by anyone. Since the infested culms were left upon the fields the resulting winged insects were not destroyed, hence they issued during the spring of 1892 and greatly extended their domain. The very causes that killed off the armies of young migratory locusts, i. e. excessive moisture, protected this new pest.

"From the rather few facts which we possess in regard to this insect in Minnesota one very important conclusion may be reached. As the insects hibernate in the culms of wheat in stubble fields, and very likely remain in that condition until spring, simple remedies are available and can readily be applied. All that is necessary to kill the great majority of these insects is to destroy the stubble at this time of the year, or as soon as possible after harvest. Two methods are feasible: burning the stubble, or plowing it under. Burning can be practiced in some few cases, but in many fields there is not sufficient material to do it thoroughly. Plowing, therefore, is our best remedy, and no field should be left unplowed that contains such insects, or is suspected of containing them. A very superficial inspection of the fields will show the whereabouts of these insects, if the owner has not already detected the broken culms or heads. By splitting with a knife the joint just below the broken culm the dark puparium will be readily seen. Or if not, the discolored interior of the culm above will indicate its presence, and closer inspection will reveal the culprit. All fields that contain infested straw should be plowed, and this as soon as possible to make sure of the destruction of these insects; the rest of the fields can be plowed later. In doing this we shall be sure of one thing: the insects, although well protected against moisture, will come in lasting contact with the moist soil, the broken tube above will be filled with earth, and the fly can not escape the next spring to carry destruction near and far.

"The damage caused by this insect in 1892 was by no means small. In many places fully one-fourth of the entire crop of wheat was destroyed, and in a great many more the losses amounted at least to one tenth. As many places are badly infested, the total amount is quite large, and if no steps are taken to prevent it a repetition may become ruinously large in 1893."

Most farmers plowed their fields during the fall of 1892 or early in 1893, and consequently the losses in the latter year were small, and in 1894 but very few of these insects could be found. The spring of this year, being very wet, prevented extensive plowing, and the insects not being disturbed or plowed under again became a pest and caused considerable damage. The name "Frit-fly" is a well deserved one, as the Swedish farmers call the worthless grain resulting from the attacks of such flies: "frits."

The life-history of this insect is still very obscure in many points and careful work is required to learn it.

THE WHEAT-STEM MAGGOT.

(*Meromyza americana* Fitch).

This insect (plate XIV) has again been destructive in many parts of Minnesota, and it threatens to become in the future a serious enemy to our crops of small grains. In some parts of the state the late sown rye, which had made but little growth during the autumn and which grew slowly in spring, was greatly damaged, in some cases to the extent of one-tenth of the crop. Wheat did not entirely escape, and the plants infested by the insects showed their presence by their small size and general weakly appearance. An account of the life-history of this insect was given in last year's report, so it is not necessary to discuss now its habits in detail. Many points in this life-history are still obscure; as yet we do not even know how this insect passes the winter in Minnesota, or where. In 1896 it could be found in many regions of the state, and the prominent white "bald heads" were not difficult to find. Large numbers of the infested stalks, especially those of rye, were kept in proper vessels to see whether parasites were numerous enough to promise assistance in the near future. But few were discovered, however, and thus far the only remedy we have is a systematic rotation of crops.

THE HESSIAN-FLY.

(*Cecidomia destructor* Say).

This insect, perhaps for the first time in its history, has caused considerable losses to the farmers of Minnesota. Contrary to all expectations it has found a home in our state, but very likely only for a short time. A large area is infested, but especially the western part of central Minnesota, from Brown's Valley to the Mississippi river at St. Cloud. Farther north and south the fly is found in lesser numbers, and only few occur in the northern part of the Red River valley and along the Iowa state line. The damage in some places amounted to more than 25 per cent, in others to 5 per cent and less, but on an average our farmers lost from 5 to 10 per cent of their entire wheat crop. This is a very serious loss and one requiring close attention on the part of the farmers to prevent in future. The writer is glad to state that in many places a number of different parasites have been exceedingly numerous and active and have done such good work that the majority of the destructive flies have been destroyed.

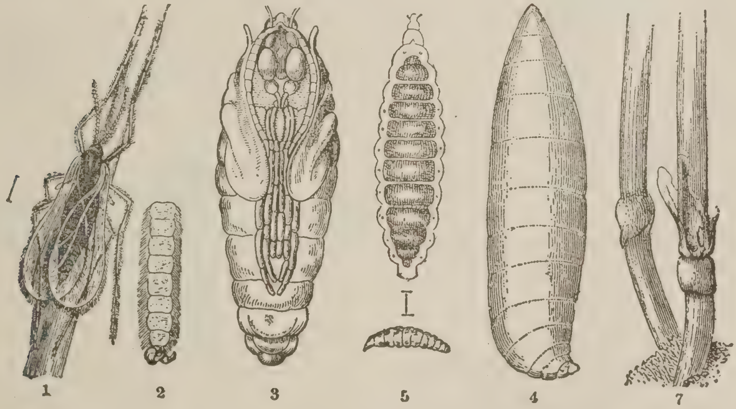

Fig. 3.—Hessian-fly: 1, adult female; 2, abdomen of male; 3, pupa removed from puparium (flax-seed); 4, puparium; 5, larvæ; 7, puparia in position. All enlarged excepitng 7. (After Taschenburg).

As the history of the Hessian-fly has already been given in last year's report it is not necessary to repeat it here. An illustration of its various stages is given in fig. 3. In southern states this insect is double brooded, and hibernates in the flax-seed stage in winter-wheat, volunteer-wheat and in other plants including, possibly, some of the larger grasses. But this is their habit only in the south: here the insect must lead a different sort of life, for instead of being double-brooded it is single-brooded. This could be expected from the conditions prevailing in the greater portion of our state, but we have had no proofs thus far. Of all the infested stalks gathered as soon as the injury became visible, not a single Hessian-fly has issued, and numerous puparia (the flax-seed stage) are still unchanged in the breeding-cages. This assuredly seems to indicate that the flies do not issue during the autumn, as they do further south, but remain in the culm until spring. Another proof, though not a safe one to depend upon, is the fact that no larvæ or puparia could be found in the volunteer plants of wheat growing near fields that had been badly infested. The many puparia kept in properly constructed breeding-cages gave forth, however, very large numbers of parasites. Three different species were raised, and in such numbers that in some cases nearly all the Hessian-flies had been destroyed in the puparia. Two of the parasites are shown in the illustration. Fig. 4 represents a female of the most common parasite (*Merisus destructor* Say) and fig. 5 the male of (*Eupelmus allynii* French). The female of the latter occurs both with and without wings.

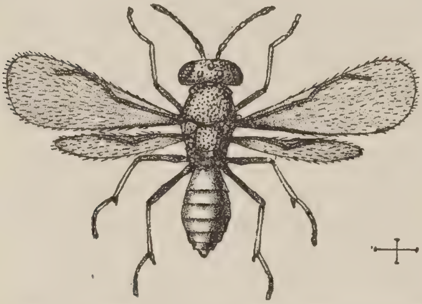

Fig. 4—Female of *Merisus destructor* Say. Enlarged. Original.

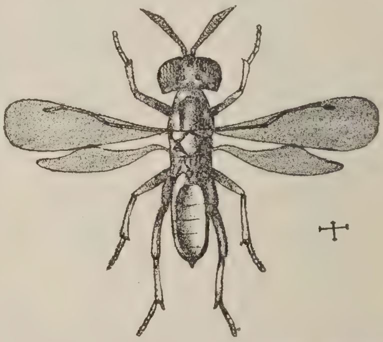

Fig. 5.—Male of *Eupelmus allynii* French. Enlarged. Original.

A third parasite (*Polygnotus hiemalis* Forbes) was also raised. It is very small and six of them found sufficient food to pass through all their metamorphoses in a single puparium of the fly. In fig. 6 is shown the broken off culm, the puparium of the Hessian-fly, and the small cocoons of this minute insect still fastened to it.

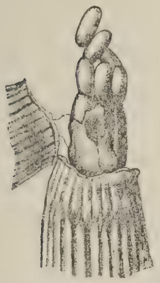

Fig. 6.—Puparium of Hessian-fly with six cocoons of a parasite. Enlarged. Original.

To find such numerous parasites is a very hopeful outlook for those farmers upon whose fields the straws containing them were gathered, and it is a very good thing for the entire state that these parasites are very numerous in many counties infested with the Hessian-fly. Straws received from other districts show fewer parasites, but not a single field was detected in which these useful insects were entirely absent. Their presence is easily detected as they make a perfectly circular hole through the straw to reach the outside of their prison; such holes are as large as a perforation made with a sewing needle.

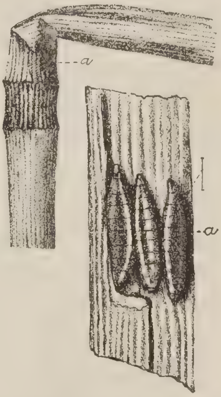

Fig. 7.—Hessian-fly: at the right three puparia (*a*) exposed; at the left puparia (*a*) and the manner in which stems bend and break. Enlarged. Original.

To show where the puparia are located in the culm of the wheat-plant, fig. 7 has been prepared. At *a* are shown the puparia; to the right three are exposed by removing the base of the leaf, and above it to the left their presence over the first joint is indicated by dotted lines. It will be seen that the culm breaks down above the infested place, and in such a way as to prevent the entrance of moisture.

If this dangerous insect is single-brooded in Minnesota, a point now almost definitely settled, a remedy is very simple, and, in most years, can be applied without any extra expense or labor. The insects, hibernating in straws usually just over the first joint, remain in the stubble until early spring, when they hatch and deposit their eggs upon young growing wheat-plants. The exact time when this takes place in Minnesota we do not know at present. To prevent the pupæ inclosed in the puparia from hatching, early plowing in autumn is necessary. In doing so the stubble containing the insects is plowed under, and the puparia and enclosed insects are in constant contact with the moist earth; this will either destroy their vitality, or the soil will become packed so tightly around them that the very delicate adult insects can not issue. If the stubble could be burned soon after harvesting the great majority of these injurious insects would be destroyed.

It is still an open question whether the growing of winter wheat will increase the danger of introducing the Hessian-flies and of furnishing them the proper conditions for existence. If the insect is single-brooded then the growing of winter-wheat will make no difference whatever; if double-brooded we furnish the insects with an opportunity for a second generation.

Notwithstanding the fact that the parasites have done such wonderful execution and have killed the great majority of the Hessian-flies, every farmer should bear in mind that these insects rapidly increase in numbers, and he should not run the risk of depending upon these small friends but plow his stubble-fields as early and as thoroughly as possible, since in doing so he will employ the only method that can protect him against this pest. Some years ago a female fly, just leaving the puparium, was dissected, and it was found that it contained 238 eggs. This shows how rapidly this pest can increase if conditions are at all favorable.

THE ARMY-WORM.

(*Leucania unipuncta* Harv.).

Many of the newspapers published in our state contained in the middle of July and the first week in August many very gloomy accounts of a cut-worm which threatened ruin and destruction to every green thing, but which preferred wheat, oats, corn and grasses to other plants. Not only our state but a number of others were equally injured by large armies of these insects. All parts of Minnesota were infested, even the as yet unsettled region in the far north, and people going there to cut wild grasses for hay came back very much disgusted, for instead of finding grasses they found multitudes of such worms. As some of the descriptions given by the newspapers would fit almost any crawling thing in nature, Mr. Pettit, the assistant, made a trip to Northfield on July 20th, to ascertain the real character of the worm and to see the extent of its depredations, as well as what means were necessary to stop their ravages. In this special case the army-worms were found in large numbers covering an area of from four to five square miles near the city, and in scattered patches over at least twenty miles in all directions from it. Upon some farms they were so numerous and destructive that it did not pay to harvest the crop, while on other farms one-quarter to one-half of it was destroyed. The grain being almost ripe, the greener portions of the fields contained the largest numbers of such worms, though they were also quite numerous in the other parts of the field. In some cases the oats were already cut and shocked; this did not, however, stop the depredation of these worms, for they climbed the shocks and destroyed all accessible grain in them. As a general rule the worms commenced their destructive work about seven o'clock in the evening, and continued it until morning. As stated by the assistant, the general direction of the moving armies was in most cases toward the north. Mr. Geo. Lyman had a large field which was completely destroyed; to protect his uninjured grain in other fields he plowed five ditches between the uninjured ones, turning the furrows toward the advancing worms, and in this manner prevented the worms from reaching the fields not yet invaded. These ditches stopped very large numbers of the army-worms. The same plan was followed by a number of other farmers, and whoever adopted it had good results.

In a number of other places where the plants were already nearly mature, or were badly rusted, only the husks were green, and these were greedily devoured by the caterpillars, thus exposing the immature kernel. As is usual the army-worms had already done most of the damage before their presence was discovered. Some fields, that looked very promising in the distance proved on closer examination to be very badly injured by having the berries exposed to the drying influence of sun and wind which shrunk them badly. A closer inspection of all fields showed at once that the worms had been at work for some time; in fact they had eaten up all the foliage and the ground was thickly covered with bits of leaves and the frass or droppings. In most of the fields the caterpillars were not forced to migrate on account of lack of food, as enough of it was still left to enable the almost full-grown worms to mature. It seems a sort of instinct that prompts them to move away from such fields and to move toward new pastures. The armies thus formed are not composed even of social insects such as the tent-caterpillar, but are more like a mass of individuals routed by a common enemy. All worms run away and do so regardless of their neighbors. When we look into the matter a little more carefully we find, as a general rule, that it is not simply hunger that prompts them to wander, but that they are frequently harassed by numbers of parasitic insects. Out of ten worms picked up we may find at least six or more that harbor in their inside the maggots of flies or of small parasitic wasps. In one case fifty worms were picked up at random and forty of them showed the peculiar china-white and glossy eggs of a fly shown in fig. 8. The adult tachina-fly (*Exorista leucaniæ* Walsh.), a little larger than a common house-fly, could also be observed in large numbers near the army-worms. It would dart toward an intended victim and notwithstanding the fact that this always tried to escape, the fly would succeed in fastening one or more eggs upon its neck. The maggots hatching from such eggs penetrate into the worm and there feast upon the material stored up to produce the future wings and other organs of the adult army-worm or moth. Other parasites were also very numerous, but their methods can not as readily be ob-

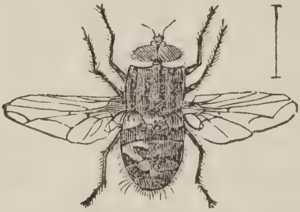

Fig. 8.—Tachina-fly of army-worm. Enlarged. After Walsh.

served. The one shown in fig. 9 inserts a number of eggs in the army-worm and the resulting cocoons, which are of a white color and surrounded with loose silk, could be found everywhere in the fields fastened to all kinds of plants, to sticks and even to loose pieces of sod. The illustration shows some of these cocoons fastened to a leaf, a single cocoon greatly enlarged, and also the adult parasite, (*Apanteles congregatus* Say), which leaves the cocoon by a neatly made circular opening covered by a tight-fitting lid. When we dig in the ground after the larger part of the army-worms have disappeared, we find, besides the red pupa of the army-worm and a large number of dying ones, also numerous very tough, brown, oblong-oval, silken cocoons from which the parasite (*Ophion purgatum* Say) shown in fig. 10 issues in due time. When we visit a field invaded by army-worms we soon see that the worms have by no means every-

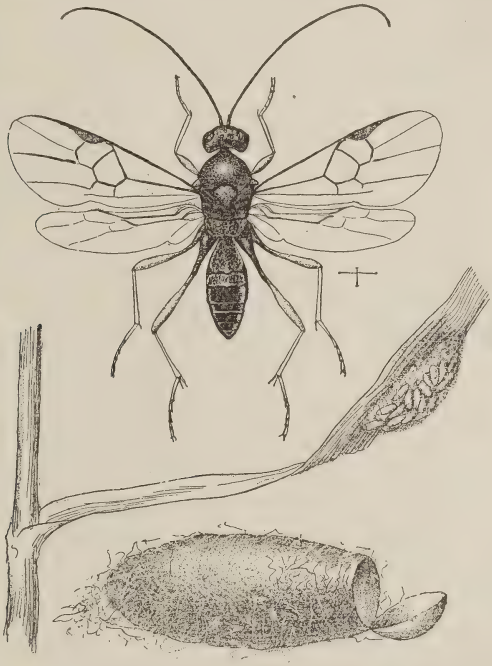

Fig. 9.—*Apanteles congregatus* Say; its cocoons, natural size, and a single cocoon with loose cap. Enlarged. Original.

thing their own way. By watching them after dark we may see numerous black beetles chasing and grabbing them with their large and pointed mandibles; and after sucking them dry, dropping them for other victims.

A large number of birds are attracted to invaded fields and, though the worms usually hide during the day, they kill large numbers of them. Our best friends in exterminating these noxious worms are, however, such nocturnal mammals as shrews, skunks, weasels, and even gophers, which devour large numbers. Considering all these facts we realize that notwithstanding the vast number of worms in such armies but comparatively few of them reach the adult stage, and it is the experience of most observing people that one army-worm season is not usually followed by another one.

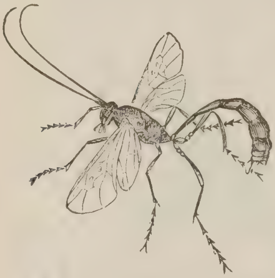

Fig. 10.—*Ophion purgatum* Say, natural size.

The life-history of army-worms is essentially that of the common cut-worms. In reality they are nothing but cut-worms crowded together in large numbers by favorable conditions, and doomed, on that account, to suffer. Army-worms can be found in every season, but in normal years they do not act as army-worms, but lead the life of a common cut-worm. The adult insects, one of which is illustrated in fig. 11 (plate II), fly in Minnesota from the middle of June till late in September, in fact some have been captured as early as May 19th and as late as Sept. 29th. In some cases large numbers are attracted to fermenting liquids, while at other times only solitary specimens can be seen. It is usually claimed that there are two annual broods of these insects in Minnesota, but we have been unable to verify this statement, and only know from experience that we can expect army-worms in a summer following a wet spring. Why this is so is not known. The metamorphosis of the army-worm can be given in a few words: the eggs, which are deposited early in the night, are thrust by means of a horny ovipositor between the folded sides of a blade of grass; usually fifteen or twenty eggs are glued together. Each female can deposit from 500 to 750 eggs, which hatch in the course of six to ten days, according to the prevailing temperature. The young larvæ, which move like geometers on account of the rudimentary first two pairs of prolegs, feed as soon as born and, as true cut-worms, only during the night, so that there may be millions in a field unknown to its owner. They require in warmer regions about one month to reach their full size. The full-grown caterpillars vary greatly in color and general appearance, but usually they have four lateral, almost equally broad stripes, of which the upper two are white, the lower two yellow. The only characteristic features of these caterpillars is their possessing a highly polished head mottled with confluent dark dots and marked by two darker lines, which commence at the corners of the mouth, approach each other near the center and recede again behind. A full-grown army-worm measures 1½ inches. Entering the ground, it transforms inside of a cell of earth into a rather stout pupa of a shiny mahogany-brown color measuring three-quarters of an inch. With us the insect hibernates as a partly-grown larva. The food consumed by the army-worm consists of grasses and cereals, including, of course, corn. During their wanderings from one field to another the hungry worms will bite into all sorts of plants, and may cause considerable damage if they pass through a field of flax; here they will bite off the seed-pods without, however, utilizing the plants for food. This bad habit makes the worm also very destructive to oats since in this case they also bite off the loosely arranged kernels and thus injure more than they eat. The usual way of catching army-worms is to trap them in ditches and dispose of them there; this can be done in various ways and one of the most simple is to partly fill a ditch with straw and when fairly filled with worms, ignite it after adding some kerosene-oil. Another way is to drag through such a ditch a short log which will grind up the worms and at the same time keep the sides of the ditch in a smooth condition which prevents the worms from crawling out again. There are other remedies by means of which the worms can be destroyed by fire or by poisoning; ditching is, however, the best and most simple remedy we have. In studying the road traveled by the armies of such worms we can usually detect where the majority of them were born, and find, as a very general rule, that this is an old straw stack. It seems to have wonderful attractions for this insect, and this being the case the removal or disposal of these useless or unsightly objects is an excellent method to prevent an undue increase of army-worms. The illustration shows the adult insect, a pupa in its underground cell, and a larva in the act of eating off the chaff from an ear of wheat.

THE ERRATIC ARMY-WORM.

(*Noctua fennica* Tausch).

As has been stated before, almost any species of cut-worm, favored by exceptionally good conditions, may become a veritable army-worm. Early last spring reports reached this office that the country about Hinkley was invaded by immense numbers of caterpillars which devoured every green thing upon the face of the ground. At the invitation of a gentleman from that place, and also prompted by curiosity to see this new army-worm, the entomologist paid a visit to the invaded region and studied the worms. The great majority of these caterpillars which are shown in fig. 12 on plate III, had already disappeared and only comparatively few were still found running about in search of food (fig. 13, plate IV). The caterpillars are velvety black with a number of longitudinal yellowish lines and have a brownish head. The presence of these worms was painfully evident as they had devoured everything in the nature of a leaf, and had, prompted by hunger, even eaten the young bark of such plants as poplars, willows, cherry, sumach and others (fig. 14, plate IV). All the foliage of the plants that had found a home in this region since the great fire in 1893 seemed to be to the taste of these worms. They preferred, however, such plants that are bitter, hence the foliage of cherries, poplars, willows and sumachs was the first to be eaten; after these plants had been denuded nearly all others were devoured and only certain grasses fared better. Owing to the rainy spell numerous pools of water had been formed in which, like islands, were some young trees, but even these had been discovered and defoliated by the hungry worms. After the wild plants had been denuded the worms made for the gardens and cultivated fields; in the former they destroyed all plants, preferring onions, which seemed to be particularly to their taste; in the latter all the small grains, just appearing above the ground, were eaten and even in large fields not a vestige of such plants could be found. Naturally the farmers, chiefly newcomers, were greatly alarmed about this invasion and many feared a repetition of the trouble. There is, however, no reason whatever to be alarmed, as the same conditions that assisted so much to multiply the worms may not occur again in many years. Nor was the actual damage done very great, as all the wild plants soon recovered and in time made a denser growth. The cereals, which had been cut down to the very ground, assisted by the moist and warm days following this invasion, not only recuperated but were in some cases even improved, as they stooled better than those not cut by worms.

An investigation of these caterpillars showed that most of them were healthy and but few parasites could be found. This shows very clearly that this insect had increased very recently and very suddenly to such alarming numbers. The only parasite found was a small wasp, the *Meteorus vulgaris* Cr., and even this insect was by no means very common.* Soon after the visit of the entomologist, in fact within twenty-four hours, all the worms had entered the ground in the usual way, had made for themselves cells inside of which they transformed to light-brown pupæ. The adult, which is rather a pretty insect and very different from the common army-worm, issued about ten days later. The illustrations on plate III show the different stages of the insect. Although large numbers of the moths were kept in captivity and fed with sweetened water, none deposited eggs. In fact they were exceedingly wild, and though chiefly active at night, were also wide-awake during the day.

Judging from experience in the past this moth is not liable to be numerous in consecutive years. Only once before has it occured in such numbers as to deserve the name of army-worm, yet for a number of years it could not be found in the same region except by a trained collector. Here in St. Anthony Park it flies in large numbers from June 29th to Aug. 26th, and as the moths gathered on sugar during this time are all in fine condition it shows conclusively that they are constantly hatching throughout these three months. This insect was also found in great numbers at Duluth.

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* A tachina-fly, and two other parasitic flies were also bred from these caterpillars, viz. *Anthrax, alternata* Say and *Psilocephala hæmorrhoidalis* Macq.

THE WHITE-GRUBS.

(*Lachnosterna spec.*).

During the past few years a number of beetles proved very destructive to various cultivated and wild plants. Some of these were old and well-known offenders, while one species, a rose-beetle, formerly quite uncommon in our state, appeared in large and destructive numbers. Most of these beetles belong to the well-known family of insects usually called WHITE-GRUBS, JUNE-BUGS OR MAY-BEETLES. The genus *Lachnosterna*, which comprises beetles of this kind, is a very large one, and quite a number of species belonging to it occur in our state. Only two species, however, are very injurious, both as larvæ and adults; the smaller, *Lachnosterna tristis* Fab., is sometimes found in immense numbers in the vicinity of oaks, while *Lachnosterna rugosa* Melsh. occurs throughout the state. Fig. 15, plate II, shows both species of may-beetles. Early in June, when we pass a grove of oak trees at dusk, we sometimes hear sounds that seem to indicate the presence of bees in full activity, but as no bees fly at night we soon detect that this peculiar sound is not produced by them but by the first of the above named beetles. They do not measure much more than half an inch in length, and are distinguished from all other may-beetles found in Minnesota by their pale yellowish-brown color, which has a red tinge on the head, thorax and legs, and a more yellowish one on the wing-covers. The insect is quite hairy, especially if viewed from the side; these hairs in a fresh specimen are of a golden-yellow color. During the day none of these insects can be found except by digging for them in the ground, and even then it is merely done by accident. Toward evening, however, they leave the ground and fly to the nearest oak-tree, especially white-oak, the foliage of which they seem to prefer, and here they gather in very large numbers and their presence is soon indicated by the ragged appearance of the foliage of the trees. This time of feeding is followed by a love-feast, and numerous pairs will be found mating if we go to the trouble of investigating the oak-trees during the night. Early in the morning all beetles leave the tree and hide in the ground by digging their way into it to the depth of one or two inches; here they rest during the day but leave it at dusk to repeat their destructive operations for a number of nights. Meanwhile the eggs become large and have to be disposed of, and for this purpose the females dig their way among roots of plants and deposit here and there these large and almost transparent objects. To obtain such eggs it is only necessary to gather a number of beetles and to put them in a flower-pot filled with moist and loose soil. A large number of eggs are laid, which soon hatch into small and almost transparent larvæ that feed upon the roots of many kinds of plants, but especially upon those of grasses. These young larvæ are very tender, and resemble an irregular drop of water surrounded by a very delicate skin. As they grow older they become whitish, with brown heads and legs, and possess the well-known form of the so-called white-grubs shown in the illustration (fig. 16, plate II). After feeding one or two years, according to the species, they reach their full size, and now transform into pupæ, which already indicate in a general way the future form of the adult beetles. Here in Minnesota the pupa is formed late in summer or early in autumn, and changes soon afterward to a beetle, which, however, never leaves the ground until spring. It is not at all uncommon that such beetles are plowed up in autumn; when thus exposed they are very pale in color and very much softer than in spring, showing that they are not yet entirely mature. If exhumed during autumn they gradually work their way back into the soil, but do so in a very slow and awkward manner, and thus are so much exposed in the shallow and poorly made cell that they are killed by rain and cold. If the cells they form around themselves as larvæ for hibernating purposes are not disturbed, however, no amount of rain or severe cold will injure them. The old belief that insects go into the ground simply to protect themselves against cold is difficult to believe, for if they had to go below the frost-line in Minnesota they would have to go eight feet deep, and would have to be equiped with wonderful organs for such a purpose.

A second and much larger species is very destructive in our state; it occurs both in the wooded and in the prairie region. It is *Lachnosterna rugosa* Melsh., a reddish-brown smooth beetle with a very rugose thorax. It is shown in fig. 15, plate II). This is the white-grub that causes the most damage in our state and whose larva is so frequently mentioned in agricultural and horticultural papers. During the past season this insect has been especially destructive to lawns, and has caused a great deal of annoyance to those in charge of our public parks and cemeteries. In one case many acres of the most perfect lawns were destroyed in a cemetery, where large patches of grass turned yellow; when such spots were investigated it was found that the whole sod could be lifted from the ground, the grubs having cut off all the roots. The illustration showing the white-grubs (fig. 16, plate III) was taken from such larvæ found in the act of cutting off the roots. They, as well as those of related species, do not move in the usual way by means of their legs, but push themselves forward in a peculiar way by a wriggling motion of their backs. In other words the larvæ use their backs for locomotion, and their legs are simply utilized to pull the roots of plants toward their very hard and horny jaws. When we look at the peculiar shape of white-grubs we can clearly perceive why the legs are not used for locomotion, nor is much locomotion required, as they live underground in very short tunnels where they need to move but little, being surrounded by plenty of food. Some of our cultivated plants suffer very severely from the attacks of these insects and this is especially true of such plants as strawberries, and whole fields of them are destroyed from time to time. As these larvæ live under the ground they are not readily reached by insecticides, and consequently they can not be be poisoned like potato beetles and others. Nor can their presence be readily detected, and as a general rule most of the damage is done before we realize the cause of it. We see plants die and then by digging in the ground we find the culprits. There are a number of remedies, however, that can be used in case we detect the presence of such white grubs in time; for instance, if we find yellow spots in the lawn and on examination find the white-grubs, we can under certain conditions kill them, providing the soil is not a heavy clay and is not soaking wet. In a dry and sandy soil the application of a strong kerosene-emulsion, immediately followed by a drenching with water, will carry the oil down to where the soft insects are and kill them by contact. Four or five days after the application we find the grubs dead and black. In cases where these insects have already killed the sod we can use pure kerosene-oil and follow this with lots of water to carry it down. But after all one of the best remedies is to plow up the infested fields and give the enemies of the white-grubs a chance to eat them. All birds and mammals are exceedingly fond of these fat grubs. Wherever the latter are present in our prairies they attract large numbers of sea-swallows as soon as the fields containing them are plowed. Our black tern makes it a business to follow the plow for the sake of picking up such delicate morsels, and we see these birds constantly darting to the ground for this purpose. Wherever crows abound we find them also engaged in this good work and numerous other birds have the same beneficial habits. Such animals as skunks, weasels, shrews, gophers and even field-mice feast upon them. In the more southern part of the state the mole subsists almost entirely upon the white-grubs and angle-worms. Whenever we plow or spade in the garden we should permit chickens to witness this operation and give them an opportunity to pick up white-grubs, which they are not slow to do. If hogs are permitted to range in our fields they soon exterminate white-grubs.

Some people think that stable manure adds to the number of white-grubs, but this is only apparently the case. The larva of another beetle remotely allied to the *Lachnosterna* breeds in large numbers in manure heaps. The adult is a black and shiny beetle (*Chalepus trachypygus* Burm.), which lays eggs in heaps of old manure, from which hatch larvæ resembling very closely the injurious white-grubs, but which are not injurious to the roots of living plants.

Among the many remedies proposed against the noxious may-beetles are several that should be mentioned, because they are of some benefit. It is well known that the winged beetles are readily attracted to light, and rooms that are not protected by screens will soon contain large numbers of such clumsy beetles attracted to them by burning lamps. To attract these beetles for the sake of killing them it is customary to place a burning lamp over a pan filled with water and kerosene-oil. The insects, attracted by the light, fly against the protecting glass and, falling in the water, come in contact with the deadly oil. In this manner large numbers of beetles can be caught, but on investigating the insects captured we find that most of them are individuals that have already deposited their eggs, or we find that only one sex, usually the male, has been captured. At all events, notwithstanding the number of insects killed, the benefit is not so great as could be expected· By beating the trees at night, and gathering the falling insects into sheets and bags, large numbers of the recently emerged beetles can be caught, but such an operation requires very much labor and is consequently not a practical remedy.

All birds, and most of our carnivorous mammals, should be protected, and not killed on sight, as is frequently the case at the present time. In fig. 15, plate II, the smaller beetle is *L. tristis*, the larger *L. rugosa*.

THE COMMON HAIRY ROSE-BEETLE.

(*Euphoria inda* Linn.).

This insect has of late years become very numerous and injurious in our state. It is a hairy beetle, gray in color, spotted with black, as may be seen in the illustration (fig. 17, plate VI), which shows a number of them. Its larva possesses also the general shape and appearance of the common white-grub. The adult insect occurs in large numbers during autumn, and again in spring and early summer. The beetles flying during autumn are brighter in color, and have evidently all issued quite recently, while those found in spring and summer show considerable wear, hence it is very probable that the species issues in autumn and hibernates as a beetle, while the true may-beetles, though also mature at that season, do not leave the ground until spring.

Many complaints have been made about these sombre looking rose-beetles. In some cases they have eaten off the flowers of apple, plum, strawberries, blackberries, raspberries and others. They have destroyed the male flowers of the corn, and have eaten their way into the young ears of corn, and especially the ears of sweet corn have suffered severely in many places. Again the ripening fruit of many plants was eaten into, and when apples and berries were exposed to be dried these insects were not slow to appropriate a large share of them for themselves. Whenever a tree is injured and is bleeding, large numbers of such beetles congregate and are found in such numbers as to form clusters composed of many hundreds, even several thousands, of individuals, all intent on obtaining the sweet sap. Not unfrequently these beetles settle in the flower-heads of thistles, and feeding there become beneficial.

Poisoning their food is out of the question, and the only method we possess of reducing their number is to gather them in nets and bags werever they occur in such clusters. Jarring the trees upon which they are found in numbers quite early in the morning over large sheets of muslin will bring many beetles down, and these can be readily gathered and disposed of. During the warmer portions of the day they are very active, much more so than most other beetles, and can not be captured. When drying fruit for the winter a screen of mosquito netting will protect it against these and most other insects attracted by such tempting food.

THE POTATO-BEETLE.

(*Doryphora decemlineata* Say).

This well-known insect was described last year and it was shown in that article why it had been so uncommon during the last two years. This happy condition of affairs has ceased to exist and in many places the potato-beetle will be almost as numerous as ever. Still this is not the case everywhere, and there may be broad acres where the insects still appear only in very small numbers. If there is anything in the common saying "an ounce of prevention is worth more than a pound of cure" it can now be demonstrated. By killing the few beetles and their larvæ as soon as they appear on the potato vines, we can prevent their increase in that locality for a number of years. This is necessary, even if there should be but few insects and not enough to cause any injury. Knowing that most insects are famous on account of their fecundity, and that if left alone they soon increase past belief, a sensible farmer will take time by the forelock and prevent these enemies from increasing without let or hindrance. A good farmer will always do so and a poor farmer ought to be made to do so. This is like having certain contagious diseases prevailing in a given locality; an educated farmer will take the necessary precautions and either prevent the introduction of such diseases among his own animals or stamp it out as soon as discovered; and a poor farmer ought to be made to do so by well framed laws thoroughly executed.

Of course it is not necessary to repeat here that in such substances as Paris green and London purple we possess insecticides that always are successful if properly applied.

THE DOMESTIC CRICKET.

(*Grillus domesticus* Linn).

Lovers of descriptions of the domestic life of European nations always enjoy the remarks about the presence of the musical insects so commonly found in the older houses and homes of the middle classes and farmers, and no description would be complete that did not mention the "cricket of the hearth" which sings all night, filling the air with melody. Now this reads very well, but not every person is musically inclined and what the one calls a sweet song is considered by the other as a miserable noise. As long as there was no chance to personally study the value of the music produced by these insects opinions would vary, but since the domestic crickets have found a home in some of the houses of Minneapolis and elsewhere, there seems to be but one opinion in regard to them, and this is that they are a great nuisance. Agents whose business it is to rent houses are especially hard in their denunciations of these crickets of the hearth, called by poetic license musical insects. They say that they are very destructive, that a house invaded by them could not be rented, and they have tried all sorts of methods to get rid of them but have failed to do so in many cases. The insects are like the English sparrows, which have come to stay, and this regardless of the opinions of other inhabitants of houses.

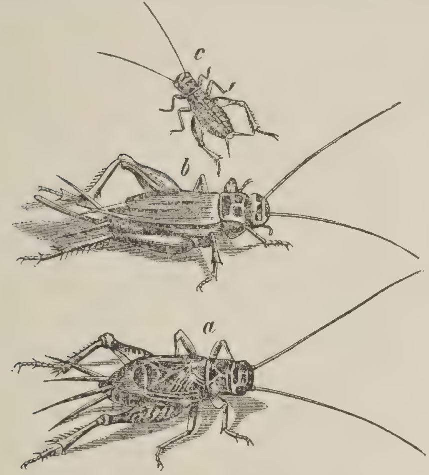


Fig. 18.—Domestic cricket; *a*, male; *b*, female; *c*, larva. Slightly enlarged. After Taschenburg.

The general history of this insect is very similar to that of other crickets. They are nocturnal in their habits and hide during the day in dark cracks and crevices, providing such shelters are dry. Their motions are very rapid, and though they are enabled to jump, their plumpness induces them to prefer running to jumping. Being lovers of dryness and warmth they are apt to make their homes near stoves in kitchens and living-rooms; and in olden times, when the fire-places were open and built of brick, they found numerous shelters in such places, hence their name "Cricket of the hearth." Their mere presence in our houses would not be so very bad if it were not for the fact that the adult males were so active in producing love-songs by scraping their upper wings together, and judging from these long-continued songs their love is of a most lasting character. These wings are transformed for the purpose of producing sounds into a sort of musical instrument. During their love-season, which according to some lasts all the year round, they become very noisy at night and if at all numerous, sleep becomes an impossibility to people of a nervous constitution. Their numerous eggs are deposited throughout the warm season, or as long as the male produces music, but chiefly in spring. By means of a long ovipositor the female hides the elongated and yellow eggs in the earth of its home or nest, and the young hatch in the course of ten to twelve days. The young crickets resemble the adult ones, and after undergoing a number of transformations, assume the winged form without having passed through a resting pupal stage. The insect, having been domesticated for so many centuries, has in course of time somewhat changed its habits, and this accounts for the fact that we can find them in all stages at almost any time, though most of them winter as pupæ and adults. Wherever numerous some of them leave the house during summer, and exist out doors, preferring stone walls and out-houses for their domiciles, but they all return to the warmer houses as soon as it becomes cold. During the summer they are sometimes attracted to the electric light. Being domesticated they eat many things that the wild species of crickets, which are more or less carnivorous, would not eat. But they have not lost their appetite for the flesh of insects, and if a number of them are confined over night in a small box but few badly crippled specimens will be found in the morning; the hind legs, which drop off quite readily, have nearly all been devoured, and of the weaker individuals only portions of the skin remain to tell the story of a cannibalistic feast. House-crickets are now very general feeders, and sometimes cause damage by eating clothes, especially if these are wet; in fact it seems that they are attracted by moisture and the general belief that if a cricket has been killed its relatives will take revenge by eating the clothes of the murderer is based on this preference.

It is not very difficult to prevent the undue increase of these noisy and uninvited tenants of our houses and there are a number of methods by which we can succeed. They are attracted to such tempting baits as carrots, which can be poisoned, and which will kill them in large numbers. The safest way, however, is to destroy their homes, not our houses, but the shelters in them that they prefer to occupy. The brick pavement under stoves should be laid in such a manner that the insects can not force their way underneath which they are so well enabled to do, their legs being formed for digging. All the cracks should be hermetically sealed, and especial attention should be paid to the foot-boards which, as a general rule, do not fit tightly against the walls. The space between them and the walls should be filled in and a close fit should be made by means of putty. By taking away their breeding-places and homes we soon force them to leave our houses; they are very apt, however, to migrate to more hospitable people.

The illustration (fig. 18) shows the adult insects as well as a young cricket. The insect is of a light leather-brown color and marked with darker brown spots upon the head and two triangular brown spots and a band upon the thorax. Head and legs are lighter colored. As can be seen the male is distinguished by the musical instrument it carries on its back while the female possesses a long ovipositor.

THE BOX-ELDER LEAF-ROLLER IN 1896.

(*Cacœcia semiferana* Walk.).

These leafrollers (illustrated on plate XV) which caused so much damage to box-elder trees in St. Paul in 1895, could again be found in considerable numbers during the early part of the year, but as the rainy weather in spring and early summer was decidedly to their disadvantage and to the benefit of the trees no very serious damage was done. Many of the trees were attacked, but the foliage had obtained an early start and as the worms were forced to eat wet foliage they grew but slowly. Still, if the parasites in 1895 had not greatly reduced the numbers of these worms most trees would again have been denuded.

Some experiments with Paris green were carried on to demonstrate the value of this poison against the insect in question and experiments with "Raupenleim" (caterpillar-glue) were also made to test its value against insects of this nature.

As the worms travel about considerably it was thought that raupenleim, which is a thick, viscid, tarry substance made during the process of refining petroleum, would prevent the ascent of the young caterpillars from the egg-masses, which are laid on the rough bark, to the smaller branches. Rings of raupenleim were accordingly spread around all the larger limbs and upon as many of the smaller ones as possible; this was done before the eggs hatched. Four small trees, about fourteen feet high, and two very large trees, were thus treated on April 26th. On May 13th, no effect of this application could be detected. The failure of the raupenleim to catch the insects was largely due to the dusty condition of the streets at that time, as the dust, blown about by the winds, was caught by the sticky material and soon changed its surface into a crust over which the insects passed in safety.

On May 1st the eggs began to hatch and on May 7th the young caterpillars had commenced to curl the leaves and to eat them. On May 13th four small trees on St. Alban's street in St. Paul were sprayed with Paris green and water, using a level teaspoonful of Paris green to a pailful of water. A quantity of milk of lime was added, using about twice as much lime by weight as Paris green. Six hours after spraying rain fell and continued to do so for several days, so that the Paris green was almost completely washed off, but the interval between spraying and the rain was sufficient to poison and destroy nearly all caterpillars. A few remained, however, and on May 25th the spraying was repeated. This time the Paris green remained on the foliage longer and only a very few caterpillars escaped death by poisoning, and these were killed later by a third spraying.

On June 6th two large trees on University avenue were sprayed with Paris green of the same strength; unfortunately a very heavy rain fell within two hours after the spraying and it was feared that the work had been done in vain, but as an inspection showed later, the time had been sufficient to kill the great majority of caterpillars, and in a few weeks afterward the trees showed a marked superiority over those not sprayed.

The above experiments demonstrate that this destructive caterpillar can readily be kept in check by the use of Paris green and at a very slight cost. But we can not expect that the owner of a few shade trees will go to the expense of buying a spraying outfit, even if this should be much cheaper than it is. It seems to the writer that as the city receives the benefit of having beautiful and shady streets it should also provide for keeping the trees that make them so in a healthy and vigorous condition, free from dust and worms. It would be best to place the Park Commission in charge of the trees ornamenting the streets, and let them see to it that they are not defoliated year after year. This need not be an expensive undertaking as the evil can or should be nipped in the bud by paying proper attention to the trees and their needs.

THE GRAPE-VINE LEAF-HOPPERS.

(*Typhlocyba spec.*).

For a number of years the above insects have been more numerous than usual and have caused considerable annoyances and losses, and as they seem to be still on the increase it was considered important to discover methods and means to prevent their increasing injuries. Not only have our grape-vines suffered very greatly, but the beautiful Virginia creepers, so often utilized to adorn houses in and about the cities, have also been more or less injured by these leaf-hoppers. A glance at fig. 19, plate V, reveals how a grape-vine leaf is disfigured by the numerous insects seen resting on its underside; here are also shown other white objects, the characteristic empty pupal skins. A leaf infested with these insects has a mottled appearance, and in course of time becomes yellow, brown, and eventually drops off. The larger illustrations show a larva, pupa, and two different adults.

Early in the season the vine-yards in the vicinity of Lake Minnetonka were reported to be suffering again from these insects, and the assistant, Mr. Pettit, made a number of trips to make some experiments. He visited especially the vine-yards of Mr. Reel, at Christmas Lake, who kindly assisted him in many ways, and gave him permission to utilize his vines for all and any experimental purposes with the hope of being, perhaps, able to check the ravages of these minute insects. As most persons growing grape-vines know from sad experience how these insects look it is not necessary to describe them in detail; the illustrations show their general appearance much better than words could express it. Four different species were found, all about the same size and shape, only varying in markings. The most common ones were the two species illustrated, of which one is *Typhlocyba vulneata* Fitch, and the other one *T. comes* Say. The former is a reddish-brown insect marked with white lines and dots and also with two prominent black lines at margins of upper wings; the latter is of a translucent white color prettily marked with red lines and prominent black spots at the tip of wings and two black lines at margin. The younger stages of both are very pale and the insects in that period are almost as active as the adult ones, though lacking, of course, the wings. They will dodge about in a most amusing way, and as they, like the adult ones, jump readily they are not easily captured. Like all insects belonging to this order they are active and take food as soon as born, not passing through an inactive pupal stage like beetles and moths. They take their food by suction, hence the application of such poisons as Paris green or London purple is of no avail, though it will kill, by contact, some of the still very tender and younger specimens, or even adult ones while they are just shedding their skins and are still very soft and unable to clean themselves. The only remedies that promise success are insecticides which kill by contact, as kerosene-emulsions, tobacco-teas and others. The former, to be of any use at all, should be applied very early in the morning, when the insects are less active than later in the day. Mr. Pettit tried a number of different insecticides, and his report is given below. When he investigated the vines he found that the leaves showed already at that early date, (May 20), considerable injury; they were somewhat withered and curled, appearing scorched and very unhealthy.

Report of Mr. R. H. Pettit.—During the spring and early summer several trips were made to Christmas Lake, and the following experiments were made

"On May 20th a mixture of kerosene and water was applied with a knapsack sprayer having a special arrangement for mixing the two liquids without previously making an emulsion. This liquid was used in the proportion of one part of kerosene to fifteen parts of water, and the vines were thoroughly moistened with it. During the spraying the leaf-hoppers rose in swarms and many fell to the ground, but the greater part of these recovered and flew away to return in the course of half an hour. A few were rendered inactive and appeared paralyzed for a time but very many of these recovered in less than half an hour. The mixture seemed to produce no permanent effect upon the insects, simply because the integument of these minute beings is very smooth. To remove the offensive fluid the insects used their spiny hind-legs very diligently and with success.

A solution of tobacco-soap in the proportion of two ounces of the soap to one gallon of water, and another one of one-half pound of whale-oil-soap to the same amount of water was applied. Mr. Reel reported on June 10th that neither had been of much use, and that even a few hours after the application but very little difference could be detected between plants treated and not treated.

On July 3rd another trip was made for the purpose of trying a tobacco-extract sold as "Scabcura Sheep-dip." This mixture was applied with a knapsack sprayer in two different strengths; one row of vines was thoroughly sprayed using two ounces of the extract to one pailful of water, and another row was sprayed using four ounces of the extract. The effect was immediate and at the end of two hours but very few of the pests could be seen on the plants. On Aug. 25th Mr. Reel reported as follows: "I am pleased to be able to report that the grape-vines upon which you experimented show a much better foliage than the adjacent rows—although the hoppers appear on them to some extent, the foliage is not so badly browned. I am satisfied that by spraying in the spring, while the leaves are not too thick, it might drive them away. The stronger solution is by far the most effective one." The action of this extract is almost wholly that of a repellant, and but few, if any, of the insects are killed. At the same time another test was made of the effectiveness of the kerosene and water spray against the leaf-hoppers which were at this season largely immature; three strengths were used, viz: 1:10, 1:15, 1:20 of water, and beside spraying several rows of vines, leaves which were covered with insects, were picked off and sprayed separately. It was found that when 1:20 was used it killed very few, 1:15 killed many of them, while 1:10 killed the great majority, but the difficulty of reaching all the leaves and thoroughly spraying the whole vine was very great as the foliage was at this time fully developed and very dense, and the insect invariably hides on their under side."

The above report shows that an extract made of tobacco, and sold under the name "Scabcura Sheep-dip" proved of considerable value, and that if applied early in the season we possess in it the means of protecting our grapes. Experiments early next year will show better, however, the true value of this substance.

Prevention is always better than cure, and much can be done to prevent the undue increase of these insects. They winter in all kinds of rubbish found in and about the vineyards and adjoining woods and fields. All such rubbish should be collected and burned after the first frosts have driven the insects into their winter quarters. By doing so many are killed by the fire, and still more are exposed to the inclemency of the winter and perish. This burning should be general, as the insects migrate to some distance to find suitable quarters for winter; hence the rubbish or dead leaves in neighboring woods should also be burned. The neighbors should unite in this work because if one person in the midst of many vineyards should neglect to do his duty he can harbor enough of these insects to endanger all his neighbors' vines. If mulching is used this material will offer, as long as still fairly fresh, most excellent hiding-places for these leaf-hoppers; and especial care should be taken to prevent them from utilizing such places for hibernation. This can be done in various ways, depending upon the conditions; but everyone recognizing this danger will doubtless find means to lessen or overcome the same.

A number of other methods have been used with more or less good results. By attracting the winged insects with a light many can be destroyed; hence a brightly burning torch is slowly carried at night along the rows of vines, which are at the same time disturbed to start the leaf-hoppers. Another plan is to carry a shield covered with a sticky substance between the vines during the hottest part of the day, and thus catch the insects that have been driven off the plants by beating these lightly with a stick.

THE CELERY TREE-HOPPER.

(*Cicadula 4-lineata* Forbes).

During the early part of July a small tree-hopper resembling that found on the grape-vine, but very much larger, was doing considerable damage to the celery plants in the vicinity of the Twin cities. As the injury did not seem to be very widespread and as the insect is probably to be controlled by the same remedies as is the grape-vine hopper, it was not thought best to carry on very extensive experiments with it until the success of the experiments on the latter insect could be determined. Raupenleim was tried as a repellant, but the results were not satisfactory. Probably the best remedy is a spray with the tobacco-extract described in the article on the grape-vine tree-hopper; this, while it would injure the sale of the celery if applied late in the season, would probably prove very effectual earlier and before the plants are too far advanced. The culprit, which is a rather handsome insect, is illustrated in fig. 20. It is of a bright green color, marked with a few black spots upon the head, the under-side of which is illustrated to show the sharp and pointed beak which is inserted into the tissue of the plant to abstract the sap. Plants infested by many

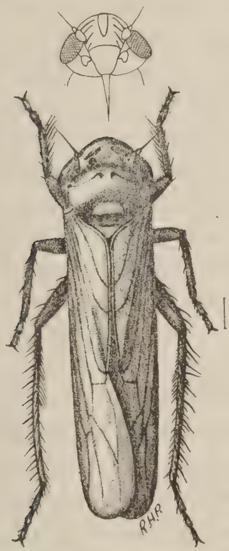


Fig. 20.—Celery tree-hopper. Enlarged. Original.

sucking insects of this kind wilted and died; it seemed as if a poison was injected by the insect while imbibing the fluid food.

THE LILAC-BORER.

(*Sesia syringæ* Harr.).

In last year's report were described a number of our most common and destructive lepidopterous borers. Since that time another species has become very prominent; it is a rather beautiful moth resembling very closely a common paper-nest hornet. It greatly resembles the borer so very destructive to our ash-trees, but confines its operations to that beautiful, ornamental and hardy shrub, the lilac, in the older trunks of which it occurs in large numbers and which it soon kills. An illustration of the living insect is given in fig. 21, plate II.

As far as remedies are concerned but very little can be accomplished beyond a removal of the old wood. The presence of such borers is indicated by numerous holes and by the frass or saw-dust accumulating beneath. By coating the old wood very early in June with a mixture of soft-soap and Paris green we can repel the female and thus prevent her from laying eggs upon such plants. The soap will soon wash away but the poison is left in the cracks of the bark and all insects boring though it must necessarily come in contact with the Paris green and die in consequence.

THE PLUM-GOUGER.

(*Coccotorus prunicida* Walsh).

There is no kind of fruit that promises so well in Minnesota as the plum and wonderful progress has already been made in the past to improve our wild species, and to create, by selection, crosses, or other means, new and better varieties, and it seems, when we look at the samples of plums shown last year at the different fairs that before very long fruit far superior to all others grown now will be the result of such painstaking work. It seems to the writer that the only true road to success has been chosen, viz: to improve the native kinds, which are known to be hardy, and not to attempt to bring to our state others found in countries differing in climate from ours. We have, in improving our native plums, to follow the same steps that were taken in the past in Europe to change their native crab-apples into the beautiful, delicate varieties of apples now grown everywhere. But to grow plum-trees and to harvest plums are two quite distinct things. A little observation will almost convince the horticulturist that he is growing the plums not for his own use but for that of his enemies. He sees that after a plum orchard is once established these have taken possession of the same, and seem to consider it their own. There are few plants in Minnesota that have more enemies than the plum tree: black knot, plum pocket, powdery mildew, brown rot, plum leaf-blight, plum rust, leaf-spot or gun-shot and others are a few of the more important vegetable foes of this tree, while plant-lice, such as the plum-tree aphis, the plum gall-mite, many caterpillars, the plum-gouger and the plum-curculio are the more destructive insect enemies.

The plum-gouger, fig. 22, plate VI., is the most destructive of the above named insects in Minnesota. It is a reddish-brown snout-beetle, with a peculiar pruinose, almost velvety,surface and of a very different shape than the better known but less common plum-curculio. Last spring (May 9) the plum trees upon and near the Experiment Farm were in full bloom and promised rich returns. But before long one flower after the other dropped off, and but comparatively few were left upon the trees, and in some cases none remained. When studying the cause of this trouble it was found that this snout-beetle was busily engaged in gouging holes in the flower (see fig. 22), which in consequence shrivelled and dropped. A rather suicidal way of doing things, as by acting in this manner the beetles actually destroyed their future food and home! As the fruit grows, the female beetle in depositing an egg does not form the crescent-shaped mark of the "little turk," but makes for this purpose a deep and small puncture. Prof. Bruner describes the egg-laying habit of the plum-gouger as follows: "The *modus operandi* is very simple, and requires but a minute and a half to two minutes for the performance of the entire operation. She first spreads out to their full extent all of her legs, braces them, and then draws her beak or rostrum to as nearly a perpendicular position as possible, then by gnawing and with a twisting motion soon works her snout into the young fruit until it is buried a trifle above the bases of the antennæ, the latter being held close against and directed upward along the rostrum upon the head while the hole is being made. She now draws out her beak and deliberately turns about, and after a few preliminary thrusts of the ovipositor inserts the latter into the hole just made with the beak and deposits a single egg that is of the same diameter as the puncture. The egg is of a dirty whitish, somewhat transparent color, and is plainly visible with an ordinary pocket lens, being uncovered and nearly flush with the surface. It soon becomes covered by a healing of the injured fruit." Each female deposits only one egg in a young plum; if more are found it is the work of several females. The larva that hatches from such an egg is never exposed, hence can not be killed by sprays with arsenical poisons. In entering the fruit a transparent or gummy substance collects over the puncture, as is well shown in the illustration. The larva feeds not upon the flesh of the plum, but upon the flesh of the kernel inside of the stone. Here it undergoes its transformations from a larva to a pupa and to the adult insect, which later leaves as soon as strong enough to do so, and searches for hibernating quarters in and about the orchard. Many of the plums that contain the worms drop and should be removed and destroyed, but many others remain on the trees long after the beetles have left, and some of them are even still fit for culinary purposes. There is very little use in spraying. Jarring early in the season, at the time the trees are in full bloom, or even a little sooner, will bring down many of these injurious beetles, and if this is done early in the morning they can be readily gathered and killed. The jarring has to be done in a forcible manner, as the beetles cling very tightly to the tree.

Another species so closely resembling the above species as to be almost indistinguishable, is found upon the sand-cherry. It has similar life-habits.

THE PLUM-CURCULIO.

(*Conotrachelus nenuphar* Hbst.).

We can hardly open an entomological bulletin issued by any of the eastern, central, or southern states without finding a description of this insect, and of the remedies that will kill it and save the fruit. Yet as a very general rule more is claimed for such proposed remedies than is warranted by facts, and many of the measures have not proved very satisfactory. This is especially true of the applications of Paris green and London purple, which, with Bordeaux mixture, are now-a-days a sort of cure-all. All these substances are of great value, but as far as the "Little Turk" is concerned we have to depend for success very largely upon other methods, which, though requiring much more labor, are also much more certain. Though so well known it is perhaps best to give an outline of the life-history of this insect which is illustrated in fig. 23 upon plate VII. As the illustration shows, this snout-beetle is less than one-fourth of an inch in length, is of a brown color with four sealing-wax-like elevated excrescences on the hard wing-covers. The beetles hibernate among all sorts of rubbish, but prefer accumulated leaves and similar substances. Early in spring, and long before the buds of the plum-trees open, they visit the orchards, and eat the tender parts of the tree, such as green bark and buds; later they eat leaves, flowers, and the young fruit. Knowing this habit we can kill large numbers of the curculios by spraying the trees before their leaves and flowers appear. This should be done thoroughly and as the foliage otherwise so very tender as regards arsenical substances is still enclosed, there is no danger of injuring the trees. When the flowers open we should not spray; it is more or less useless, and we run the risk of killing many honey-bees, which are attracted to them and very important, as without them but few fruits will set. As soon as the latter have reached the size of a small marble the female curculio commences to deposit her eggs; she makes a crescent-shaped cut and then separates and elevates a small flap into which the egg is inserted. This peculiar crescent-shaped slit has given the insect the name: "Little Turk;" it is made, apparently, to deaden the flesh of the fruit, or to delay its rapid growth, which otherwise might injure the enclosed delicate egg. This hatches in a few days, and the whitish larva or worm, also shown in the illustration, bores at once into the interior of the fruit until it reaches its stone, which it never enters, however, as is the case with the plum-gouger, which always does so. The work of the larva is also shown. Though we can not poison the larvæ which are hidden inside the fruit, a second spraying about this time will do some good, as the females continue to deposit their eggs for a long time and require some food. As such spraying will kill also many other injurious insects of the plum-tree it should not be neglected.

By midsummer the larva has reached its full size and leaves now to pupate; it does so in the earth beneath the tree, and the pupa soon changes to an adult insect. As soon as able to move the freshly issued beetles search for hibernating quarters and are not seen again in the orchard until next spring.

As will be seen from the above account of the habits of this insect it is not readily combatted by arsenical poisons, though two applications of them will do considerable good. Those who will apply either Paris green or London purple for this purpose should recollect that the foliage of the plum is very easily injured by all arsenical poisons, and that it is absolutely necessary to add at least equal parts of quick-lime which will neutralize all soluble arsenic and thus prevent injury.

The old remedy of jarring the trees every day or two over some sheet is after all the most successful one; in doing so during the day, when these beetles are not very active, they drop very readily and can be easily gathered and destroyed. The trees should be jarred, not simply shaken. It seems that by jarring we imitate the vibrations produced by the hammering of woodpeckers, and the curculios drop to escape them, while shaking simply imitates the motions produced by the wind. There are also a number of patented and unpatented devices to catch these insects by machinery, which jar the tree, collect the beetles and grind them up. More cannot be expected from one machine! "All fallen fruit should be picked up" is a rule that should be strictly followed in every orchard. If the owners of trees have no time for this purpose let them permit turkeys and chickens to do so; even hogs and sheep may be made useful.

There are many other methods in vogue, and a few of them are of some use. Shingles laid close to the trunk of a tree to be protected will offer early in the spring a shelter for the beetles that have fed upon the trees during the night and which towards morning leave it—on foot—to hide during the day. By turning over and inspecting these traps many beetles can be found and destroyed.

PARASITES OF MAN AND DOMESTICATED ANIMALS.

INTRODUCTION.

The edifice of the world is only sustained by the impulse of hunger and love.—Schiller.

The numerous letters received during the last few years from farmers, stock-raisers, dairymen, poultry-raisers and others, show that many of our domesticated animals suffer more or less from parasites, and as these special branches of farming receive now more and more attention, a short treatise on parasites will be of some use.

The term parasitism is used in this treatise in its widest sense, and the parasites mentioned in it may be living upon the hosts infested, permanently or only for a short time.

In the struggle for existence animals and plants have been forced to adopt all sorts of peculiar methods to live; most of such methods are above-board, but others are at least dishonest or even worse. The majority of such beings are like honest farmers and mechanics; they till the soil or otherwise work for a living. Many, however, are not so honest, they rob the substance of others and thrive upon material not produced by them or belonging to them. These, at first perhaps by force of circumstances, became in the beginning simply occasional beggers or robbers, but as they enjoyed such an easy life, in course of time their off-spring became so modified in form and structure that they could no longer take care of themselves but had to lead the dependent mode of life first adopted by their parents. Most of the so-called parasites belong to this group of organisms, be they animals or plants. They lead all sorts of peculiar and dark existences; some simply utilize the host, or the organism upon which or in which they are found, as a means to reach the source of needed supplies, and in this case the hosts are simply the carriers of tbe parasites; others live upon surplus food or upon food not entirely consumed by their hosts; still others make use of the host himself, by eating part of the same; and a few not satisfied with being such contemptible beings, commit even murder by enfeebling and killing the host that provided them with food and shelter.

Farmers have to fight almost constantly against all kinds of parasites, since otherwise their hopes of rich returns for their labors in the fields would come to naught. And yet how few farmers realize how much they lose year after year by the inroads of such pilfering beings, simply because these live a hidden life not easily observed. They, with other enemies such as plant-eating insects, take every year the lion's share of our crops, and some vegetable parasites, such as rusts, smuts, and similar lowly organized plants, not infrequently destroy all the plants so carefully planted and cultivated by the farmer. Some still smaller parasites, as certain kinds of bacteria, cause diseases among man and domesticated animals, and frequently to such an extent that they are swept away or decimated over a large area. Other parasites live inside man and his two or four-footed friends, and cause great losses, by weakening or even killing them. Still others, less dangerous but equally annoying, and in extreme cases as bad, live upon the various kinds of domesticated animals, and cause all sorts of trouble and diseases. And even man, the crown of creation, is not entirely immune; even he, not excepting her, has been seen—in other States of course—to scratch himself, or to investigate with great industry the heads of her promising offspring.

All parasites dwell either upon the bodies of their hosts or inside of them, for a short time or permanently, and as they subsist upon substances of great and even vital importance to the latter they cause more or less serious disturbances, even fatal diseases. Such parasites belong either to the vegetable or to the animal kingdom. It is not the intention to discuss the former, or all of the latter, as being foreign to an entomological report. Only such parasites will be discussed as are either genuine insects, or so closely allied to them as to be usually considered as such. They will be described in as few and simple words as possible, and as the portraits of all species found thus far in Minnesota will be given, those interested will find no trouble in recognizing them.

We divide the animal parasites mentioned in this report into two groups:

1. EXTERNAL PARASITES (*Epizoa*) which live upon the skin, and

2. INTERNAL PARASITES (*Entozoa*) which live inside of the organs and tissues of their hosts.

I. EXTERNAL PARASITES. (*Epizoa*).

A. FACE-MITES; BLACK-HEADS. (*Demodecidæ*).
B. ITCH-MITES. (*Sarcoptidæ*).
C. HARVEST-BUGS; JIGGERS. (*Trombidiidæ.*)
D. GAMASIDS. (*Gamasidæ.*)
E. TICKS. (*Ixodidæ*).
F. SUCKING-LICE. (*Pediculi*).
G. BITING-LICE; FEATHER-LICE. (*Mallophaga*).
H. FLEAS. (*Siphonaptera*).
I. LOUSE-FLIES. (*Hippoboscidæ*).
J. OTHER FLIES. (*Diptera*).
K. BUGS. (*Hemiptera.*)
L. OTHER INSECTS.

II. INTERNAL PARASITES. (*Entozoa*).

A. FIVE-MOUTHS. (*Linguatulidæ*).
B. BOT-FLIES. (*Œstridæ*).

I. EXTERNAL PARASITES (*Epizoa*).

A. FACE-MITES: BLACK-HEADS.

(*Demodecidæ*).

These singular parasitic beings do not exactly fit into any classification, at least naturalists have disagreed about their true position until quite recently. But they are no doubt mites with quite an anomalous structure, so much so in fact that they might be said to form a sort of transition from annelids or worms to arachnids or spider-like animals. As they have many points in common with itch-mites, which are described next, it has been thought best to discuss them in this place.

Face-mites live in the sweat-glands at the roots of hairs and in diseased follicles in the skin of the human face, chiefly about the nose, eyes and chin where they cause the well-known comedones or black-heads; they also occur in a number of domesticated animals. Such diseased follicles become filled with a plug of fatty matter the upper end of which is usually hardened and blackened. If these "black-heads" are forced out by pressure the minute mites may be found in all stages of development. To detect them more readily it is necessary to dissolve this fatty matter in a drop of oil or ether. The young mites possess six legs, the adults eight; both are quite worm-like in appearance, their elongated abdomen is transversely wrinkled; their mouth is a suctorial beak possessing dagger-shaped mandibles with two palpi. In the adult parasite the four pairs of legs are very short, two-jointed and each armed with four claws.

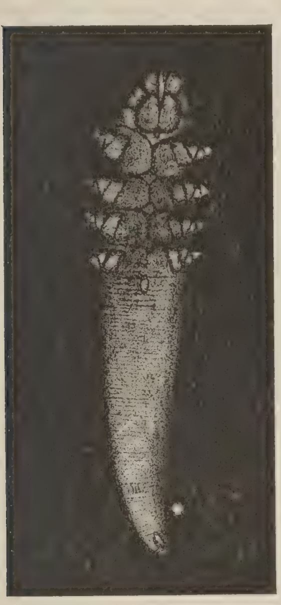


Fig. 24. Face-mite of man, greatly enlarged. Original.

These mites cause no harm to man except marring his or her beauty, but they can severely injure dogs, cats, hogs, sheep, horses and cattle; sometimes they even produce upon them a scab-like disease called the "red-mange," and in extreme cases they can cause the death of their hosts. Dogs and cats sometimes suffer very much from their presence, and in the case of a dog as many as ten to one hundred and more mites have been found in a single hair-follicle. In bad cases the hair falls out, and the skin becomes covered with a reddish scab, which is very difficult to eradicate, and almost never without the loss of all the hair; in fact a cure is considered impossible by many veterinarians. The illustration (fig. 24) shows the general appearance of an adult face-mite of man.

There are a number of so-called species found upon different hosts, but all are very similar, and the description and figure of one is sufficient for all.

The Face-Mite of Man (*Demodex* (*Simonea*) *folliculorum* Sim.) (fig. 24) was discovered in 1842 by Simon. It is not a dangerous parasite to man, but if transmitted to a dog, as was purposely done, the mites rapidly increase upon this new host and in a short time cause very serious trouble. In man these mites prefer such parts of the face as are free from hairs. They are very small, the male measuring 0.30 by 0.04 mm., the female 0.40 by 0.05 mm., the heart-shaped egg is 0.08 mm. long.

The Demodex of the Dog (*D. folliculorum var. canis*) was discovered in 1844 by Tulk. Its head is almost square. This parasite produces at first small swellings, which gradually unite in large sores containing 50 to 500 and more mites; such sores are chiefly found upon the throat, breast, abdomen and inner surfaces of the thighs.

The Demodex of the Cat (*D. folliculorum var. cati*) was discovered by Leidy in the noses and ears of cats infested by *Sarcoptes minor*. This species is exceedingly small, and infests most frequently the head of its host.

The Demodex of the Hog (*D. phylloides suis*) was discovered in 1878 by Csoker.

Other species of Demodex occur upon the cow, sheep and deer.

The Demodex of the dog especially is a very dangerous parasite, and by no means very uncommon, causing an almost incurable disease, the red scab or mange; and whenever it finds a home upon an unfortunate dog the animal soon becomes ill and dies. This mite prefers the hairy skin of the host. Here it causes either a disease of a squamose nature, in which the epidermis becomes scurfy, the hair drops out, with little inflammation, or of a pustulose form with intense inflammation and the formation of pustules in and about the glands of the hair. If purposely introduced from the dog to the skin of man, it causes an itching sensation, and soon afterwards a sore spot and a scab. As proved by many trials it is a very fortunate thing that this parasite does not readily migrate to man. Fig. 25 shows a number of the parasites in the hair-follicle of a dog.

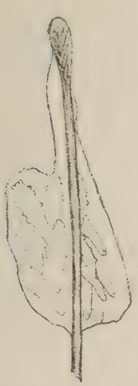


Fig. 25.—Demodex of the dog; mites shown in hair-follicle. Greatly enlarged. Original.

Remedies.—The disease caused by these parasites upon domesticated animals is not easily cured, and only in the early stages is a cure possible. In this case salves or ointments made from salicylic acid, or a mixture of one part benzine to 4 to 8 parts of soft soap, do good service. A strong kerosene-emulsion would also, no doubt, be of great value, especially if an extract of pyrethrum is added. An ointment made of half a pound of lard, 2 ounces of tar, and 4 ounces of sulphur, rubbed in before a fire or in the sun, is very effective, if it is allowed to remain on the skin for some days. Peruvian balsam, a salve made of corrosive sublimate (1:100), Creolin (2: 100), Lysole, Styrax (1: 30 oil), a salve made of cantharides (1: 6 fat) are also recommended. Several other washes are frequently used which will be given later. Success depends much more on the manner in which the medicinal agents are used than upon the agent itself, and the strongest ones may prove perfectly useless if not properly applied. Nothing short of a thorough rubbing in of the salves will suffice, and this operation has to be performed many times. Of course the patient should be well fed, as even after the death of the parasites the skin is for a long time in an inflamed condition. Cleanliness is here also the best preventive, and the diseased animal must be isolated and its old sleeping place should be thoroughly disinfected.

There is still another species of Demodex, similar to the one infesting the dog, that has repeatedly been more or less injurious to cattle. Mr. W. Faxon first called attention to the diseased condition of cow-hides received in Boston from

Illinois and Minnesota. The leather from the hides appeared disfigured with pits from one to six millimeters in width, which in many cases penetrated nearly through its entire thickness.

B. ITCH-MITES.

(*Sarcoptidæ*).

In former times, and even quite recently, doctors did a very strange and unheard of thing; they disagreed among themselves, and this about the cause of a well-known disease called the itch. They did so because they could not always, easily and readily find the itch-mites in the burrows made by these parasites. Consequently other explanations for the itch were given such, as "special fermentations," "thickened bile," "irritating salts," "drying of the blood," "melancholic juices," and other equally convincing ones. During the late war, when the itch became very common, and for some very good reasons too, they invented such terms as "army itch" or "seven-year's itch." A soldier having the latter disease could of course not expect to become well in a few days or weeks, and was consequently sent home to spread the itch among other people.

Itch-mites are the cause of a disease called acariasis or itch in man, of mange in horses, hogs, dogs, and cats, and of scab in sheep and chickens. Wherever this disease occurs it is invariably caused by these parasites, which burrow in self-made tunnels in the skin of their hosts, live free upon them or snugly hidden under scales or hairs. They either feed upon the blood of their host, or gnaw and destroy the younger epidermal cells. It has been claimed, but not proven, that these mites inject a poison in the skin to cause a more rapid flow of blood to the injured spot. Since these mites live in or upon the skin all internal applications or remedies are in vain, because they do not reach the source of the evil, and can not kill the invaders without killing the host.

The itch-mites, a number of which are illustrated, have flat bodies, with a striated skin, and a roundish or squarish shape; their eight short legs, which extend but a short distance beyond the body, are supported by bands of harder substance (chitin), and usually possess at their ends toes with suckers. Itch-mites take their food by means of peculiar nipper or needle-like mandibles, and as they lead a burrowing life they need and possess no eyes. Neither do they possess a respiratory apparatus, the respiration being cutaneous. The different kinds of itch-mites are chiefly distinguished from each other by the number and position of the spines, by the hooks on the tarsi, and by the chitinous bands. Fig. 26 shows the structure of head and leg of a member of this order of parasites.

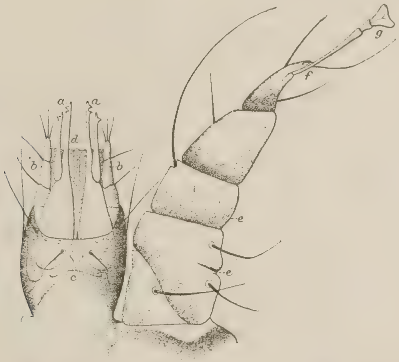


Fig. 26.—Head and front leg of scab-mite, ventral view; *a*, mandibles; *b*, antennæ; *c*, maxillæ; *d*, membrane joining the antennæ; *e*, *e*, joints of limb; *f*, claw; *g*, ambulacrum or sucker. Greatly enlarged. After Curtice.

Itch-mites are all very small, and for this reason not readily detected, though some, for instance the one causing the mange of the horse, can be seen with the naked eye. Notwithstanding the small size of the mites causing the itch in man it was already known to be the cause of that disease as early as 1197, and it had already been closely observed and illustrated by Wichmann in 1780. Yet all real knowledge of this case of cause and effect seems to have been lost, and the Academy of Science in Paris offered in the beginning of this century (1812) a prize of $1500 to anybody who could demonstrate its existence. For a long time no one could produce this mysterious being, until at last a certain doctor Gales mystified and tricked the Academy and pocketed the prize. He showed to a medical commission selected for this purpose, a mite which he claimed to have taken directly from a patient suffering with the itch. He was awarded the prize, and received in addition to it a medal for his great discovery; it was shown later that he had palmed off a common cheese-mite for the itch-mite. Many physicians searched for the mite in vain, mislead by the book in which Gales had the audacity to publish descriptions of the parasite. In 1829 another prize was offered by Lugol, and a student of medicine, Renucci, showed at last in 1834 a way by which it could be found. He simply utilized a method used in Corsica and elsewhere to kill the mites by removing them with a needle.

We can distinguish three groups of itch-mites:

1. **Burrowing-mites** (*Sarcoptes*), which make tunnels in the skins of their hosts and which live by sucking blood. All members of this group can successfully migrate from an infested animal to man, and cause upon this new host the itch, which disease, however, may again disappear without the application of remedies.

These mites have a round or slightly oval body, a short beak margined by two cheeks, short, thick and conical legs, of which the two posterior ones are quite or nearly concealed beneath the abdomen; the tarsus has often an ambulacrous sucker in the form of a simple and somewhat long pedicel; the male possesses usually no copulatory suckers and never has abdominal lobes.

2. **Skin-eating Itch-mites** (*Psoroptes*), which live only upon the surface of the skins of their hosts, or among the crust they form by irritating the skin, and which feed upon young epidermal cells by gnawing the upper surface of the skin and hairs. Such mites, if they reach the skin of man, do not cause the itch.

These mites have the body oval; the beak conical, elongated and destitute of cheeks; the legs are thick, especially the front ones, and all are visible beyond the sides of the body; the ambulatory suckers are carried on a long triarticulated pedicle; the male has copulatory suckers and abdominal prolongations.

3. **Sucking Itch-mites** (*Symbiotes*), which live only upon the surface of the skin, but which penetrate with their mandibles through the upper skin to suck blood, lymph and serum. Usually they can not thrive upon the human skin, though cases have been reported in which species infesting sheep invaded successfully another host, man.

These mites have an oval body; beak slightly conical, as wide as long, and destitute of cheeks; the legs long, thick, and visible beyond the sides of the body; the ambulatory suckers are very wide and carried at the end of a simple and short pedicle; the male has copulatory suckers, and more or less developed abdominal prolongations.

1. **Burrowing-mites** (*Sarcoptes*).—This genus contains two sub-genera, one infesting mammalia, the other, birds. The former contains two species, the common itch-mite (*Sarcoptes scabiei* De Geer), and the dwarf itch-mite (*Sarcoptes minor* Fuerst.).

The common itch-mite (*Sarcoptes scabiei* De G.) is found on man and on a large number of mammals, where it causes the ordinary itch or mange. The parasite varies according to the species of mammals upon which it lives, and not alone in dimensions, but even in secondary anatomical details. Formerly these varieties were described as so many species. The following varieties are found upon our domesticated animals:

MANGE OF HORSE (*S. scabiei* var. *equi*).
SCAB OF SHEEP (*S. scabiei* var. *ovis*).
SCAB OF GOAT (*S. scabiei* var. *capræ*).
SCAB OF PIG (*S. scabiei* var. *suis*).
MANGE OF DOG (*S. scabiei* var. *canis*).
MANGE OF WOLF (*S. scabiei* var. *lupi*).

According to Fuerstenberg this last variety causes the Norwegian itch mentioned later.

THE ITCH-MITE OF MAN.

(*Sarcoptes scabiei* De G. var. *hominis*).

This mite (fig. 27 and 28) is very minute, whitish, and barely visible to the naked eye unless moving over a dark surface. Its body is rounded and soft, in the female with small roundish scales upon the middle of the back; in the male with but few isolated scales; the surface of the body has radiating lines or ridges. The mites resemble in a general way a minute tortoise, are very sluggish during the day, but become quite active during the night in a warm bed, and can even leap to some distance. The head is distinctly separated from the rest of the body, and possesses four pairs of jaws which are needle-like. The mite has eight legs, four in front and four behind; when young, or as a larva, it has but six legs. The sides of the body and legs bear long bristle-like hairs; there are six upon the thorax and fourteen upon the abdomen. The males (fig. 27) are quite different from the females (fig. 28), are much smaller, and have bell-shaped suckers upon the ends of their legs. The female is about one-sixtieth to one-seventieth of an inch in length (0.45mm. long and 0.35mm. wide), the male (0.23mm. by 0.19mm., and the

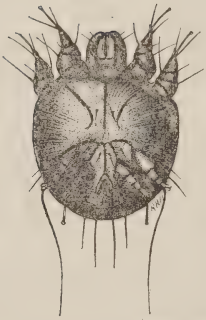


Fig. 27.—Itch-mite of man, male. Greatly enlarged. Original

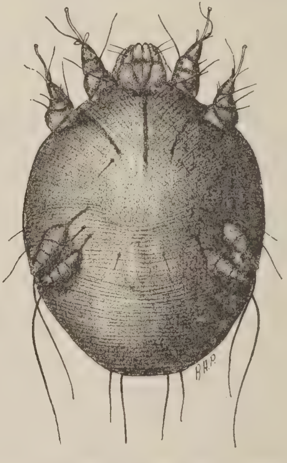


Fig. 28.—Itch-mite of man, female. Greatly enlarged. Original.

eggs 0.14mm). This species has been found upon man, ape, horse, sheep, lion, llama, ferret, and other animals.

The itch-mite lives in self-made burrows just beneath the epidermis or scurf-skin. These burrows (fig. 29), called by physicians "acarian furrows," extend through the deeper layers of the epidermis to and into the true skin. During the existence of the mites in the burrows, which are similar to the underground tunnels made by a mole, the mite moults three times, without, however, greatly changing in general appearance except in size. The eggs, large in comparison to the size of the mother, are elongate-oval, with a smooth skin. From 20 to 24 eggs are said to be deposited at a time, and they hatch in 4 or 7 days. Such eggs, if kept in moist surroundings, remain good from three to four weeks. The mites, if removed from the host, can also exist for a long time if kept moist, but die in four to six days in dry surroundings. The female mite, as she progresses in digging a burrow, lays the eggs behind her, and soon dies. These eggs can be seen in a regular row in the burrow (fig. 29).

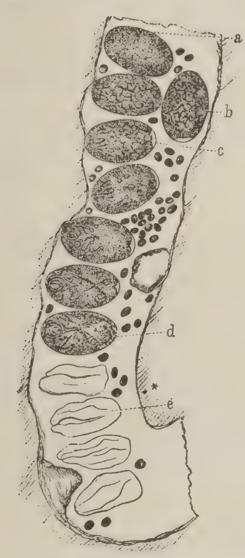


Fig. 29.—Acarian furrow; *a*, freshly laid egg; *b*, eggs showing segmentation; *c* to *d*, eggs showing embryo; *e*, empty egg-shells; the black spots are excrement. Greatly enlarged. After Heller.

We know the skin of the host is constantly wearing off and as constantly renewed by new growth from beneath. This being the case the eggs in the burrow will reach the surface just about in time to hatch and to permit the young animal to escape. These burrows are from one-twelfth to a quarter of an inch long and possess a serpentine form. They can be detected below the surface of the skin as a whitish dotted line, the dots corresponding to the eggs. Over the entrance made by the mite there is usually a little pimple on the skin containing a watery fluid. When we try to obtain the mite by puncturing this pimple we never succeed, as the parasite is some distance away in the blind end of the burrow.

The mining and boring operations of the mite cause intense itching and irritation of the nerves of the skin, and quite often an inflammation, which produces peculiar eruptions on the surface. This intolerable itching causes the one infested to scratch himself incessantly, and the patients have no rest on that account, and consequently tear and lacerate their skin in all directions. But not all portions of the body of man are suitable for these intruders; they need a soft skin to enable them to enter. This is the reason that we usually find the first indications of the itch between the fingers, where the skin is tender, and here the peculiar looking burrows can be readily detected. The region infested by this unpleasant parasite of man is so definite, that those familiar with skin diseases can detect their presence at once.

REMEDIES.—How can we separate ourselves from these intimate friends? They are hidden beneath the tough layers of our skin, which have to be removed to reach them; next we have to apply something that will come in contact with the intruders, that will kill them but not injure us; and finally we have to cure the eruptions and sores caused by such constant scratchings. Of course a great deal depends upon the length of time a person has been affected, or in other words upon the number of mites he harbors, and upon the sensibility of the skin. It is well known that the longer the parasites are neglected the more numerous they become. It is a good thing, however, that their increase in numbers is quite slow; if the mites are not destroyed by proper methods they will flourish just as long as the host lives. To kill them we must first of all soften and remove the loose epidermis of the patient. Everyone ought to be familiar with the effect of a long-continued application of warm water and soap to the skin; this treatment swells up the scurf-skin, softens the same, and enables us to scrape or rub it off. Soaking in hot water and rubbing all parts of the body with strong soft-soap is the first step to remove this very unpleasant intruder. To do this well requires about half an hour's work. Of course for very delicate skins this operation can or should be greatly shortened. Next it is necessary to kill the parasites. For this purpose the common sulphur-ointment should be rubbed thoroughly over the body, and if this operation is performed well all mites that were exposed by the previous rubbing and came in contact with this medicine, are killed. Those patients who possess a tougher skin can have this ointment left on over night, when it should be removed by a hot bath in the morning. Of course a thick-skinned laborer needs a very different treatment than that of a delicate child. If the patient possesses a very tender skin sulphur-soap can be substituted. A solution of sulphuret of potassium in water, two or four ounces to the gallon of cold water, varying the strength according to the age of the patient and the tenderness of the skin, is also a very safe wash. As the odor of this substance is very unpleasant it should only be used where plenty of ventilation can be had. All these substances will succeed if thoroughly applied; a few mites left could soon multiply again and cause fresh trouble. To prevent this the wash should be applied at least th ee times, at intervals of three or four days, to destroy the young mites as fast as they hatch. There are many other remedies, such as sulphur, tar, naphtol, styrax, Peruvina balsam and others, and specialists of skin-diseases have a large choice of substances and methods of applications adapted to the purse of the patient, and to their cutaneous sensibilities. But we strongly advise anyone suffering from this nasty disease to apply to a physician, and let him conduct the treatment. All underclothes should be washed most thoroughly in very hot water, bed clothes must be heated to 100° C. for several hours to destroy the mites. The outer garments, contrary to expectations, do not need such a vigorous scouring.

As the parasites live in the skin of their hosts, contagion comes from personal contact, particularly from hand to hand, and the most high-bred, refined, or cleanly persons are not exempt.

NORWEGIAN ITCH-MITE OF MAN.

(*Sarcoptes crustosæ* Fuerst.).

This itch-mite is very similar to the common one infesting man, but is smaller and darker. It was first described in Christiana, Norway, and seems to be confined to that country, though it has several times been found elsewhere. It has so far as known not been found in Minnesota, and it is to be hoped never will find its way into our state, as it is a very much worse parasite than the common itch-mite.

SCAB OF HOG OR THE SCALE-BEARING ITCH-MITE.

(*Sarcoptes scabiei* var. *suis*) or (*Sarcoptes squamiferus* Fuerst.).

This mite is found upon the skin of dogs, hogs, goats, sheep, and probably of man, where it produces scab. The upper surface of the female bears a number of triangular scales, which are not arranged in regular rows. The first row of scales commences behind the first spines upon the thorax. Head and legs are more hairy than in the common itch-mite. There are 6 sickle-shaped thorns upon the thorax, and 13 or 14 pointed ones upon the back.

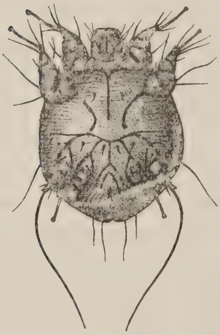


Fig. 30.—Scab-mite of the hog, male. Greatly enlarged. Original.

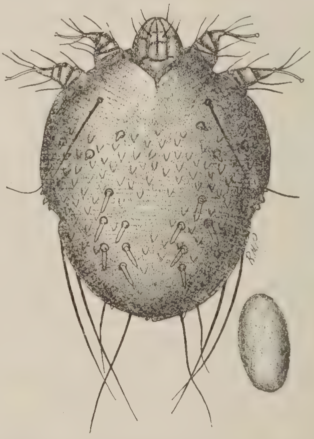


Fig. 31.—Scab-mite of the hog, female and egg. Greatly enlarged. Original.

The length of the male varies from 0.25 to 0.32 mm., that of the female from 0.40 to 0.48 mm.; the former is 0.39 mm. wide, the latter 0.35 mm. The eggs measure 0.17 mm.

The illustrations (fig. 30, male and fig. 31, female and egg) were made from specimens which infested some hogs in the vicinity of the State Experiment Farm. The legs of these animals were in a terrible condition, showing that mites had been permitted to inhabit them for a long time. The strange and ridiculous thing about this case was the fact that the hogs were condemned to be killed as suffering from hog cholera.

THE MANGE OF THE HORSE.

(*Sarcoptes scabiei* var. *equi*).

This itch-mite is found upon the horse, ass, and mule, but can also migrate to man where it will thrive as well. Though very small it can be readily detected moving among the scurf of an infested skin if a strong magnifying lens is used. Like the other true itch-mites it forms small galleries beneath the scurf-skin, in which it hides and multiplies. If the hide of an infested horse is warmed by the sun, or in a warm stable, the mite becomes very active, and is found quite readily by those trained in such work. Prof. Law writes that to obtain specimens "it may be needful to tie the scab on the human arm till a prickling is felt, when the acarus will be found in the centre of a minute papule caused by its bite." The writer did not think it absolutely necessary to offer his arm for such a purpose, and this accounts for the fact that no illustration has been made of this parasite. Perhaps some reader may be inclined to offer his assistance, and after isolating the mite in the above manner to donate it to the writer so that a picture can be made.

Like all true burrowing itch-mites they can not exist for a long time if removed from their burrow and exposed to the dry air; in moist places they can exist, however, for many days, even for several weeks.

Horses, etc. invaded by such parasites show the presence of them by their restlessness, which is caused by their incessant itching about the heads, manes, tails and backs. Here numerous open sores and scabs make the presence of the itch-mite very certain and plain.

REMEDIES.—"Remove scabs by soapsuds and brush, and apply a tea made by boiling 1½ ounces of tobacco in two pints of water. This application should be repeated after fifteen days to kill the new brood that may have hatched in the interval. Cleanliness in the stable is another important factor, and if a case of this disease has been found in a stable, all blankets and rubbers should be boiled, and the walls should be whitewashed with quicklime containing one-fourth pound of chloride of lime to the gallon."

THE HEAD-SCAB OF SHEEP.

(*Sarcoptes scabiei* var. *ovis*).

This variety of the common itch-mite is very small, almost invisible to the naked eye. It presents some characters not found in the other varieties, but they are of very little importance to the flockmaster.

Dr. Cooper Curtice describes this disease in "The Animal Parasites of Sheep" as follows: "Head scab begins on the upper lip and about the nostrils; more rarely it may show itself for the first time about the eyelids and ear. In these places there is less hair and grease, affording the pests better opportunities of getting at the skin. From these starting points the scabs spread over the forehead, cheeks, eyelids, and occasionally over the space under the jaws. In badly infested sheep the disease may sometimes spread over the fore limbs, under the belly, around the joints, and especially between the folds of the knees, hocks and pasterns. Sheep with coarse dry wool are more likely to suffer than those with fine, oily, and soft wool. Long wool seems to offer a barrier to its progress, for the invasion of parts covered with short wool is much more rapid. The demarkation between the invaded parts of the head and the healthy wool-bearing portions is quite abrupt."

REMEDIES.—As these parasites thrive chiefly upon the parts of the sheep and goat that are only covered with short wool or hair a cure is easy. When found no time should be lost to apply the proper remedies, as the presence of such itch-mites will affect the health of the invaded animals. Early treatment of such cases is all important, and if the parasites are detected soon after having found a home upon the sheep, a thorough application of scab-dips or ointments will destroy them. In cases of longer standing the scabs have to be softened and loosened by some kind of grease or oil before the dip is applied.

A number of different dips will be given later under sheep-scab.

THE MANGE OF THE DOG.

(*Sarcoptes scabiei* var. *canis*).

This disease is also caused by the presence of itch-mites, and can be cured in the same way as in other animals.

THE SMALL ITCH-MITE.

(*Sarcoptes minor* Fuerst.).

This itch-mite causes the mange of cats and rabbits, and received the correspending names of *S. cuniculi* and *S. cati.*

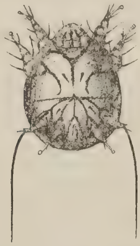


Fig. 32. Scab-mite of cat, male. Greatly enlarged. Original.

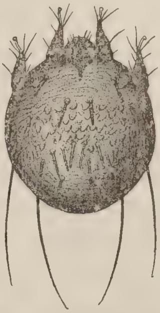


Fig. 33. Scab-mite of cat, female. Greatly enlarged. Original.

This parasite is considerably smaller, the male measuring 0.18mm. in length and 0.14mm. in breadth, the female 0.25 and 0.20, and the eggs 0.10mm. The female has a large number of long and very small scales upon the back, the male but a few. Thorns upon the thorax are not present, while twelve can be counted upon the dorsal side of the abdomen. Fig. 32 shows the male, and fig. 33 the female mite.

These parasites attack at first the head, and chiefly the base of the nose, lips, ears and eyes of the host. On account of the hairs they make very tortuous burrows, which can, however, be readily detected in such places. As the parasites become more numerous, and thus cause more violent and frequent scratching, the parts affected soon become covered with a hard and very offensive looking scab. The sores gradually extend over the shoulders and even over the back and sides, and by degrees poor pussy becomes weaker, and her skin increases in thickness, forming stiff folds around the neck. Soon inflammation sets in, extends to the nostrils, obstructs respiration, and at last the head enlarges beyond all proportions. In time, if not checked, the whole body becomes thus diseased, and the animal can scarcely drag itself along. It is really and truly devoured while still living, and thus suffers until death puts an end to its miserable existence.

This disease is much more frequent in cities than in the country, because the cats have greater opportunities to come in contact with mangy ones and thus become the abode of this parasite.

Remedies.—The same remedies that relieve man of the presence of these horrible parasites will also cure the mange of the cat.

As mentioned before the genus *Sarcoptes* contains two sections or sub-genera; the itch-mites of the first, or those infesting mammals, have been described, and it remains to mention those infesting birds. A large number of mites infest birds, but do not produce an itch-like disease, as they simply absorb the blood of their host, and being nocturnal in their habits cause loss of sleep; both factors together weaken the infested bird. But there are several genuine itch-mites that utilize chickens, turkeys, pheasants, parrots, thrushes, crows and small birds in aviaries as dwelling places.

THE CHICKEN-SCAB.

(*Sarcoptes mutans* Rob. or *Knemidokoptes viviparus* Fuerst.).

This mite selects such portions of the skin as are free from feathers, and causes a peculiar itch upon the legs of the bird (fig. 35), sometimes extending to the head (fig. 36), where it forms discolored spots. The mites possibly reach the combs of chickens when the latter are scratching these organs, or when they peck at the itching legs. Combs invaded by this mite show white dots and lines covered by minute scales, which rub off quite readily; below them the skin is brownish, contrasting strongly with the normal red color. Later the feathers on the head undergo a peculiar change; they turn whitish, lose their glossy appearance, and stand on end. Infested legs are distinguished by greyish-white spots or scabsof various shapes and sizes, and by brownish swellings in the skin, and in extreme cases by a greatly swollen and scabby appearance. Under these scales wesee a yellowish substance in which are the numerous burrows of the mites. The scabs thus formed give the legs a very peculiar and unsightly appearance—they look "chalky."

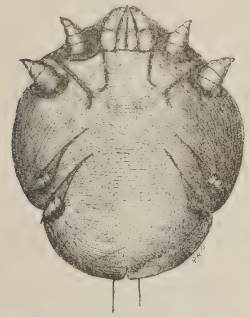


Fig. 34. Scab-mite of chicken, female. Greatly enlarged. Original.

All the actions of the fowls show that considerable itching takes place, which, however, does not as a general rule destroy the appetite of the patients. The young and six-legged mites are fairly active, and one diseased fowl will soon scatter the infection to all other birds living in the same roost.

If we investigate, by means of a microscope, a small piece of the scab caused by these parasites, we find in most of the burrows small and young mites, and in the blind end of the burrow large females and males. But we do not find eggs in such burrows, as we do in the case of other itch-mites. Prof. Fuerstenberg discovered that these mites produced living young, and therefore changed the former name of these mites, *Sarcoptes mutans*, to the second name used above in parenthesis.

These mites possess a round and very flat body, as can be seen in the illustration (fig. 34), and they are further characterized by the absence of spines on their backs. The average size of a female is 0.314 by 0.307 mm.; of a male 0.230 by 0.165 mm. The latter differs not alone in being much smaller, but also by possessing a different shape.

The disease can be communicated not alone to other fowls but even to man and to the horse.

REMEDIES.—Creolin, which is highly recommended as a remedy against itch-mites and other parasites, was tried upon a hen with badly infested legs. The comb and head, from which the feathers were dropping, showed also the presence of mites. The right foot was soaked in a ten per cent solution of creolin, the left was soaked in one of five per cent, while the head and comb was also washed with a solution of the latter strength. On the following day, (March 12th), the treatment was repeated, and again on April 4. At this latter date a very marked improvement had taken place, and the scab and scales so prominent upon the legs before were fast disappearing, and new feathers commenced to grow upon the naked spots upon the head; the brightly colored comb also showed improved health, being no longer pale and spotted. But little difference could be detected between the effects of the two applications of different strengths.

2. **Skin-eating Itch-mites** (*Psoroptes*).—Mites belonging to this genus of itch mites are also very small, and can only be studied by means of a microscope. Their round or oval body carries a short and thick cylindrical head, broader than long, with two claw-like mandibles and two three-jointed feelers. The striated skin carries two long spines and eight stiff hairs starting from round chitinous bands. Beside these the female has stiff hairs upon the back and sides of abdomen, but chiefly two larger and two smaller spines and two cylindrical projections at the posterior end. The male has at the end of the abdomen two clasping organs, each of which bears three spines and a sword-shaped

organ. The adult animal has eight legs, the young six. The roundish male has one fine claw on the first two pairs of legs, two larger ones on the third, and none on the fourth and last. The mites moult four times.

This genus contains a single species, the *Psoroptes communis* Fuerst. Besides the characters already given for the genus it is only necessary to state that it also occurs in numerous forms upon a number of domesticated animals, upon which it causes crusts by pricking their skins. The differences between these forms or varieties are not great, but sufficiently so to give them each a name according to the host upon which they occur.

THE COMMON MANGE OF THE HORSE.

(*Psoroptes communis* var. *equi*).

This disease caused by parasitic mites is the most common and longest known of all skin-diseases of the horse, ass and mule. It can appear upon any part of the body except the extremities of the limbs, but it is most usually found upon the upper part of the neck, the root of the mane, the poll and the tail. The mites live in colonies on the surface of the skin, hiding under the shelter of hairs, and their presence is readily discovered. Fig. 37 shows the two sexes of this mite. If we take some scabs from the invaded parts and put them upon black paper, we can even with the unaided eye see numerous mites moving about actively in all stages of growth. The mites, in feeding upon the surface of the skin, make punctures, and these soon form a crust, and as the parasites multiply rapidly they cause before long similar symptoms to those produced by the true burrowing itch-mites. The constant irritation caused by their presence forces the horse to the most energetic rubbings, which add to the inflammation of the skin, and the sores and ulcers thus produced are often impregnated with blood.

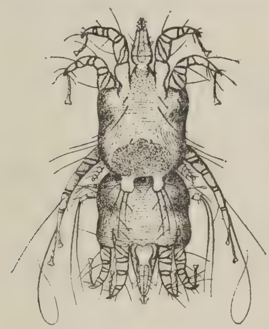


Fig. 37.—Mange-mites of horse; male and female. Greatly enlarged. After Meguin.

These parasites are very hardy, and consequently any treatment to remove them must be very thorough to succeed. They have been known to be able to exist for thirty days in the moist atmosphere of a stable away from the horse, and fourteen days in dry air; they may even recover after six or eight weeks when subjected to moist warmth. Fecundated females possess greater vital resistance than males, and these more than non-fecundated females. Pastures in which mangy horses have been kept are dangerous for six to eight weeks to healthy horses on that account.

REMEDIES.—What will kill itch-mites will also kill these skin-eating mites, and any of the proposed remedies against scab-insects will answer if applied thoroughly and repeatedly, so as to kill the eggs as well as the mites. Not alone the parts affected, but also the adjacent regions should be treated. In case of common horses two parts of tar mixed warm with one part of soft-soap, and well rubbed into the diseased patches on the skin by means of a brush, will eradicate the mites.

THE MANGE OF THE OX.

(*Psoroptes communis* var. *bovis*).

This disease is very similar to the one caused by the mites upon the horse. It usually commences at the root of the tail, at the neck or withers, and gradually extends to the head, back, shoulders and finally invades the entire surface of the body excepting the limbs.

REMEDIES.—The same remedies indicated for the mange of the horse are applicable. The disease in either case can only become serious when it has been neglected, as it yields readily if the applications are repeatedly made in a thorough manner.

THE COMMON SHEEP-SCAB.

(*Psoroptes communis* var. *ovis*).

The following description of this itch-mite, and the different methods of curing the disease caused by its presence, are copied from the bulletin No. 16 of the Minnesota Agricultural Experiment Station, published by the writer in April, 1891, and which is now out of print.

"It is no longer a theory but a well established fact that large portions of our state are well adapted to sheep husbandry. A dry region, covered with small-leaved plants and grasses, is essential to success, and no good results can be expected upon low or swampy lands, nor in very dry and dusty regions, which are neither good for the animals nor for their wool. Sheep are the only domesticated animals which can fully utilize the vegetation of our wild prairies, as they graze down to the very roots of nearly all plants growing there. With the exception of the seeds of some species of grasses (*Stipa*), that are injurious to them, in extreme cases even causing death, all other plants are eaten with impunity, even should they be poisonous to other stock. By means of sheep husbandry our farmers are enabled to fully utilize much of the cultivated land in the vicinity of their farms, as well as all the land lying fallow or in stubble. Many of the most noxious weeds introduced into the extensive cultivation of the soil can only be successfully kept in check by the use of sheep. Of course wherever the natural conditions are not in favor of this industry, or where but scant food can be obtained upon the natural meadows, farmers must either be satisfied with fewer sheep, or they must grow food for them. Frequently too many animals are kept by farmers, who can not take proper care of them, and naturally the result is a more or less complete failure. If proper attention is given to it sheep husbandry is one of the most important branches of farming, and one that pays well in more than one sense.

For most of our farmers sheep husbandry is still a new enterprise, and numerous errors in the management of the animals are the consequence. Simply possessing suitable land for this business does by no means insure success. Among the errors usually made one stands out very prominently, *i. e.* the farmers are very apt to keep more sheep than they can properly take care of; or, in other words: the sheep are left on the prairies to take care of themselves. The consequences are failure, at least in many cases. No enterprise can be a success unless proper pains are taken to make it such. Herding together large numbers of sheep belonging to a number of farmers has the very dangerous tendency to rapidly spread any disease which by separating the large flocks into smaller ones would not occur. If, for instance, one farmer is careless and allows the scab to enter his flock, his animals, grazing together with others well taken care of, will soon spread this disease, and thus force all his neighbors to go to a heavy expense to exterminate it. Concerted action is absolutely necessary to prevent this disease from entering any region, or to stamp it out if once found among the sheep. Most countries have stringent laws, well enforced, to prevent the introduction of sheep that are not perfectly healthy. We have as yet no such laws and therefore it behooves each farmer so much more to be on his guard. "An ounce of prevention is better than a pound of cure" is an old truth, and exceedingly well appliable to sheep husbandry.

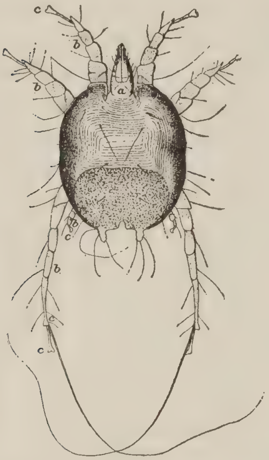


Fig. 38.–Scab-miteo sheep,male; *a*, head; *b*, *b*, legs; *c*, *c*, suckers. Geatly enlarged. After Curtice.

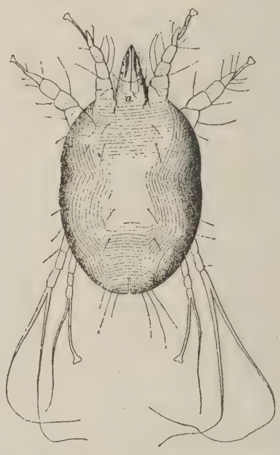


Fig.39.—Scab-mite of sheep, female. Greatly enlarged. After Curtice.

Of the three distinct species of scab-mites found upon sheep the above one is the worst and the losses caused by it are very great in some of our western states, and as the pest has found a lodgment in several parts of our own state, great care should now be taken to stamp it out, and prevent other flocks from becoming infested. Our farmers, and chiefly those that are still unfamiliar with the details of sheep husbandry, can not be too careful in regard to this disease. Wherever sheep husbandry has been well established for some time, and where farmers have learned to cure the disease, the losses caused by scab are gradually reduced by the proper use of remedies, and by the exercise of good judgment in furnishing their animals sanitary surroundings. This scab-mite can be more completely and readily exterminated than many of the other parasites of sheep.

The mite is very small, barely visible to the unaided eye; it has an elongated oval body, resembling in shape a turtle. Its skin shows numerous small wrinkles, and is covered with spines, hairs, scales and wart-like projections. The mature mite has eight legs, each composed of five joints. The illustrations (fig. 38, 39 and 26) show the male, female, and the mouth parts. The male (fig. 38) upper side, is quite different from the female (fig. 39), as can be readily seen by comparing the illustrations. The young larval mite possesses but six legs. Both males and females make burrows or tunnels in the skin of their host, but those of the former are always very short.

Neither sex lives longer than from three to six weeks, but during this time the female is almost constantly engaged in laying eggs. These are smooth objects, of an elongated oval shape, and are deposited in small patches, each containing from twenty to twenty-four eggs, which hatch in the course of four to seven days. The six-legged larvæ undergo three moults in the tunnels, and reach maturity in about fourteen days, when they leave their old quarters and start tunnels for their own use. Gerlach computed that a single female could produce in three months a progeny of 1,500,000. He gives the result in a tabular form:

First	generation	after	15	days	produces	10	females and	5	males.
Second	"	"	30	"	"	100	"	50	"
Third	"	"	45	"	"	1,000	"	500	"
Fourth	"	"	60	"	"	10,000	"	5,000	"
Fifth	"	"	75	"	"	100,000	"	50,000	"
Sixth	"	"	90	"	"	1,000,000	"	500,000	"

This estimate of their rapid multiplication, which is by no means exaggerated, but is a very moderate one, plainly proves that the farmers keeping sheep can not be too careful to prevent the scab from infecting their flocks. Mites, and their eggs as well, if removed from their abodes and placed upon a moist piece of blotting paper, or if kept in a moist atmosphere, can exist from fourteen days to four weeks, but in dry surroundings they will soon perish. This shows the necessity of preventing healthy sheep from sleeping upon moist soil upon which diseased animals have been resting. All such scab-mites seem to become more active in warm stables, and thus cause more violent itching. In the case of the human itch-mite it has been observed that the mites leave their tunnels at night, if the patient is in a warm bed, and commence to make new tunnels, hence the increased itching at that time.

The skin disease caused by the common scab-mite has a different appearance upon different breeds of sheep. Upon some breeds, characterized by wool nearly free from fat, the disease can spread over the whole body. Starting from small and isolated spots the scab extends slowly but steadily. In Merino sheep the disease is not so readily communicated, and affects mainly spots free from long wool. The first indication of the disease is violent itching, which the infested animals show by rubbing against all sorts of objects and by biting the infested spots. This itching sensation becomes more evident when the animals become heated by exercise. The sensation produced by rubbing against posts, etc., is evidently of a pleasant character to the sheep, as is shown by a trembling motion of their lips, as well as by the rapid opening and closing of their jaws. The spots of skin infested usually upon the back —show small yellowish knots, which soon change to little pus balls filled with lymph. Later this fluid is discharged and dries, forming small yellowish-brown scabs. The wool upon the invaded spots becomes paler and dry, is slightly lifted, but usually remains in position, being glued to the skin by the drying lymph. Very often these first indications are very slight, and escape detection. Separating with the hand the wool of infested animals, the presence of mites will become evident if we find round spots upon the skin, which appear whitish where the epidermis is a little elevated, and where the lymph forms yellowish thin deposits that are easily lifted with the loosened wool. In some cases the animals show pain if scratched, instead of pleasure. The skin of infected animals, if butchered, show upon their under side red points. The disease always starts from small spots, and spreads but very gradually. If neglected, the scabs become thick and of a brown color, as if soaked with oil; eventually the skin, entirely denuded of wool, becomes wrinkled, and between the wrinkles cracks appear. If the further increase of the scab-mites is not checked the animals become poorer and poorer, and die before long.

By rubbing against posts and other objects many mites and their eggs are removed, and thus frequently find lodgment upon healthy sheep. The mites can readily be found, but not in the early stages of the disease.

Remedies.—"Whatever kills the mite cures the scab" may be said to be the rule that we have to follow to exterminate them. Internal remedies have no value whatever, except in cases where the animal infested is weak, and where rich food is necessary to strengthen the patient.

Creosote, solutions of potash, alkalies mixed with fat, oil of turpentine, benzine, kerosene, tar, tobacco, hellebore, mercury, and arsenic kill the mites more or less rapidly.

Vogel made some experiments, under the microscope, and found that scab-mites were killed as follows:

Within one minute by creosote, carbolic soap and benzine.

Within several minutes by tar and caustic potash solutions.

Within one-quarter to one-half hour by tobacco or hellebore.

Within one hour by soft soap.

Within two hours by arsenic.

Within four hours by corrosive sublimate.

In Europe, where all flocks of sheep are given in charge of shepherds who know all the individuals, and who notice, almost immediately, if anything is wrong with them, the presence of the scab-mite is quickly followed by the proper remedy. The shepherds, although they frequently do not know that a mite is the cause of the trouble, search for the infested spots, remove the wool already loosened, and, scraping away the scab, apply a little extract of tobacco, which they always keep on hand, or apply a gray salve, made of mercury, to which is added a little oil of turpentine. In this way the young colonies made by the mites are soon destroyed.

To kill the scab-mites in any given locality, and to prevent infection of healthy sheep, two operations have to be carried out, and ought to be enforced, if necessary, by law; *i. e.*

1. *Direct destruction of the mites*, and
2. *Disinfection of stables, etc.*

Both are most effectively carried out immediately after shearing, as at that time the scabs are exposed to view. The sheep, after being dipped, should be kept away for some time from their old stables to prevent new infection.

To kill the mites in a thorough manner, it is best to apply the remedy over the whole surface of the animal, and not alone to the region showing scab. For this purpose two baths, or dips, are required, one to loosen the scab, so as to permit the scab remedy to reach the mite, and the other to perform the actual work of killing the parasites.

For the first bath, or dip, it is best to make a solution of two parts of potash, one part of lime, and fifty parts of water, or, in other words, dissolve in 100 quarts of water 10℔ of potash and 5℔ of lime.

For the second bath, a good dip is composed of 80 gallons of water and 40℔ of tobacco. In both baths the water should be warmed to a temperature of 100° to 110° Fahr. This second bath should be applied twenty-four hours after the first one. With proper appliances, each sheep, after shearing, requires about two gallons of either fluid, and in winter, or when the wool is long, about four gallons.

It requires four men to do the work thoroughly, one to hold the front legs, one the hind legs, and one the head. The animal is kept in the bath from three to four minutes. A fourth man separates with his hands the wool, and thoroughly rubs the infested skin, using a sharp brush to remove the scab. The legs of the sheep are kept in the bath, the head must be well washed and should be immersed several times; in doing so one man should keep the eyes of the animal closed with his hands. After the bath the sheep is put in an adjoining empty box to collect the drippings, which are added from time to time to the bath. Of course the animals should be kept in a sheltered place, free from the disease, after each bath, and should be protected from the winds until dry.

This bath kills only the mites, but not their eggs, and consequently—as the egg stage lasts from three to seven days—another bath must be given seven to eight days after the first one to kill the young mites just hatched. It is usually not necessary to give still another bath after this. The animals still suffer a little from the itching of their skin, but this will gradually disappear as the sores become healed. If, however, after a sufficient time the itching does not stop, then it is necessary to repeat the bath.

Where large flocks have to be dipped tubs merely large enough to completely immerse one sheep are not sufficient, and dipping pens or tanks have to be made, through which the animals to be treated may be driven. Large boilers to prepare the dip and to heat the water are also necessary.

Disinfection of Stables, etc.—The first step necessary is to remove the dung from the stables to fields not accessible to sheep, where it should be plowed under. The earth composing the floor of the stables should be dug up to a depth of several inches and should be removed and replaced by fresh material. All the wood work in stables must be washed with hot soap suds, and white-washed to a height of five feet. Posts in or near pastures should be treated in a similar manner. After leaving the well-ventilated stables in this condition for two weeks sheep can again be housed in them.

Composition of Dips.—There are a very large number of dips recommended, and most of them are satisfactory if thoroughly well applied. A few of the leading ones are here given.

Australian Dip.—100℔ of flower of sulphur, 150℔ of quick lime, and 100 gallons of water. Mix and stir, while boiling, for ten minutes, until the mixture assumes a bright red color, then add three gallons of water. Use the dip, heated to 100°–110° Fahr. twice, at an interval of two weeks.

Texas Dip.—30℔ of tobacco, 7℔ of surphur, 3℔ of concentrated lye, dissolved in 100 gallons of water.

Nevada Dip.—Sulphur, 10℔; lime, 20℔; water, 60 gallons.

California Dip.—Sulphur, 4℔; lime, 1℔; water, enough to make 4 gallons.

Kansas Dip.—Sulphur, 22℔; lime, 7℔; water, 100 gallons.

Curtice's Dip.—Probably tobacco and sulphur form the best combination known for the treatment of scab. To every hundred gallons of water there should be used 35℔ of good strong tobacco (if stems or other inferior parts are used there should be more), and 10℔ of flowers of sulphur. This preparation, used at a temperature of 120° Fahr., will kill all mites, ticks and lice, and leave the wool in a clean condition. Has to be applied a second time in ten to fourteen days.

Walz's Dip.—6℔ of freshly burned slaked lime, 6℔ potash, 10 quarts of water; boil an hour, stirring occasionally. Add pine-oil 8℔, and tar 2 quarts. Make an infusion of 20℔ tobacco in 130 quarts of water; add the lye already made and stir. This quantity suffices for 100 sheep. Apply by immersing the sheep, separating the wool and breaking the scabs. Repeat in eight or ten days.

Law's Dip.—Take 16℔ tobacco, 3 pints of oil of tar, 20℔ soda ash, 4℔ soft soap, 58 gallons of water. This quantity suffices for 50 sheep. The tobacco should be steeped, afterwards the other ingredients should be added at 70° Fahr.

Zundel's Dip.—13½℔ tobacco, infuse in 66 gallons of water; dissolve in it 8℔ soda, add 4℔ freshly burned or slaked lime. Dilute 8℔ soft soap with hot tobacco broth, add it to the rest, then add 4℔ crude carbolic acid. Mix. This quantity is sufficient for 100 sheep.

Roloff's Dip.—For 100 sheep. Take 20℔ of tobacco, steep it with 66 gallons of water for half an hour; heat it to 95° Fahr. and add 2½℔ each of pure carbolic acid and potash.

Mix an infusion of 15℔ tobacco with 2½℔ carbolic acid and 13½℔ wood tar, pour it into 66 gallons of water at 125° Fahr., in which 3 ℔ soda have been dissolved. Use it at a temperature of 80° or 90° Fahr., and repeat in six or seven days.

Clement's Dip.—Arsenious acid 1 part; sulphate of zinc, 5 parts; water, 100 parts. The water is put over the fire, the chemicals added, and it is allowed to boil for 8 or 10 minutes. When cool enough for use the sheep is entirely submerged in the liquid with the exception of the head. The laborers should grease their arms with linseed oil, as well as the udder of ewes, to prevent the action of the astringent on the skin and on the secretion of milk.

Mathew's Dip.—1 part arsenious acid, 10 parts alum, 100 parts water.

Scheurle and Kehm's Dip. 1 pt. arsenic, 12 parts alum, 200 parts of water.

Kerosene-Emulsion as a Sheep Dip.—Prof. Gillette has made a number of experiments with an 8 per cent kerosene-emulsion, and says that a dip of this strength could be safely used. Such an emulsion is much cheaper than any of the commercial dips, and it is a matter of great importance to try this remedy very fully.

Patent dips are objectionable because their formulas are not given, and consequently may be valueless or not strong enough, and they are usually more costly than they are actually worth."

3. **Sucking Itch-mites.** (*Symbiotes*). (*Chorioptes*). Two species of *Symbiotes* are found in Minnesota, the Common Symbiotes (*Symbiotes communis* Verheyen), and the Auricular Symbiotes (*Symbiotes auricularum* Lucas).

THE FOOT-MANGE OF THE HORSE.

(*Symbiotes communis* var. *equi*).

This mite attacks the heels and lower parts of the legs, especially the hind ones, and may be present for a long time, even years, before extending upon the body of the horse. Such mites live in colonies, without excavating galleries, and cause only a local mange or scab. The presence of these, as well as the restlessness of the invaded animals, shown by stamping and by rubbing one leg with the other, indicates the necessity of a local treatment with the remedies given elsewhere.

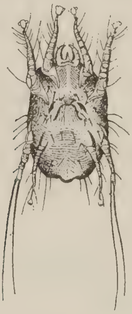


Fig. 40.—Mite causing foot-mange of horse; ovigerous female. Greatly enl'g'd. After Neuman.

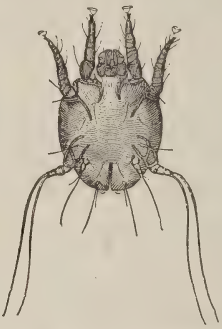


Fig. 41.—Mite causing foot-mange of horse; pubescent female. Greatly enlarged. After Neuman.

The male of this mite measures 0.34 by 0.30 mm.; the female 0.42 by 0.27.; the egg 0.16 mm. Fig. 40 shows an ovigerous, and fig. 41 a pubescent female.

The ox and goat are invaded by similar parasites, which do not greatly differ from the above, nor do they require a different treatment.

THE FOOT-SCAB OF THE SHEEP.

(*Symbiotes communis* var. *ovis*).

This is caused by a smaller mite and is of rare occurrence. It is not a serious disease, affecting only the feet and limbs of the animal, and as it progresses but very slowly to other parts it is easily cured. One sheep in a very large herd may be badly affected for a very long time, and yet no other sheep will catch the disease. The animals invaded by such mites, show their presence by stamping, scratching and biting the affected parts. The remedies proposed elsewhere for the treatment of the common scab of the sheep can be used with good effect.

THE EAR ITCH-MITE OF THE DOG.

(*Symbiotes auricularum* var. *canis*).

As early as 1834 Hering of Stuttgart discovered an ulcer in the ear of a dog caused by an itch-mite. Since that time it has been found very often, and the parasite is by no means uncommon in Minnesota, where it affects all breeds of dogs, but especially hunting-dogs. Animals invaded by these parasites are, in extreme cases, seized by convulsions, which are frequently mistaken for epilepsy, or even for rabies. Dogs infested with such mites flap their ears very often and scratch them violently, showing the irritation produced by the parasites. They also cry loudly from time to time, become angry, foam at the mouth, and run howling against obstacles, or turn several times in a circle and fall down as in a fit. Such attacks are repeated and the animals become unfit for service and sometimes deaf. If the auditory canal is investigated it is found to be lined with a dark and ill-smelling substance, in which are multitudes of the parasites of all ages and sexes. This substance is sometimes so very abundant as to compress and push back the membrane of the tympanum. The mites (fig. 42) look like tiny white specks, oval in shape; they are very active, and if the ear is carefully watched they may be detected running about the skin. This activity no doubt greatly adds to their irritating presence.

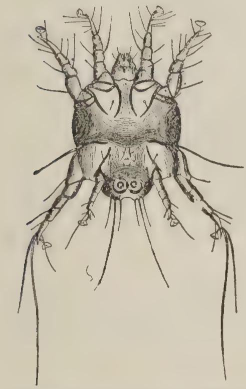


Fig. 42.—Ear-mite of dog, male. Greatly enlarged. After Neuman.

Remedies.—Wherever this parasite is found the kennels, etc., should be carefully disinfected. The ears of the affected dogs have to be kept clean, the dark substance found must be removed, and one or the other of the following mixtures should be injected.

Olive-oil	100	grammes
Naphthol	10	"
Ether	30	"

Some of this fluid, which has to be kept in a well-stoppered bottle, should be injected every day into the external auditory canal, which is then closed for ten or fifteen minutes by a cotton plug to prevent the evaporation of the ether.

A mixture of one ounce of olive-oil with one drachm of ointment of the nitrate of mercury, daily painted over the internal surface of the ear with a soft brush, has also answered the purpose. After a week the ear should be syringed out with tepid water and methylated spirit, about one to ten.

The same or a very similar parasite has been found in the ear of the cat, where it causes extraordinary symptoms, the animal being almost unable to walk; in fact, when it attempts to do so it rolls about as if intoxicated, frequently falling over on its side.

The ferret, which in many places is kept as a domesticated animal, is also affected by this or a very similar parasite.

The Itch-mites contain, besides those already described, a number of other small mites which infest birds. Such mites are found upon nearly all birds, and whoever searches for them will discover new and most remarkable forms. The two forms, male and female, shown in fig. 43 and 44, were found with others of a still different shape upon the Purple Grackle. Some of these mites are really beautiful objects, which pass through wonderful and most complex metamorphoses. Many torment their hosts, while others simply dwell upon them without causing any apparent disturbance or injury. In some cases each species inhabits only one kind of host, even a certain part of it, while others seem to care but little where they dwell providing the host is a bird. Every bird possesses one or more of such parasites, and cases are known where one bird gave a home to four distinct species of mites belonging to three different genera.

As but very few of these parasites cause real injury to their hosts excepting if they should become very numerous, it is not necessary to describe them in detail. In extreme cases they disturb, locally, the formation of feathers, and may, by deranging nutrition, cause a fatal consumption. Proper cleanliness in poultry-houses and bird-cages will greatly lessen their numbers.

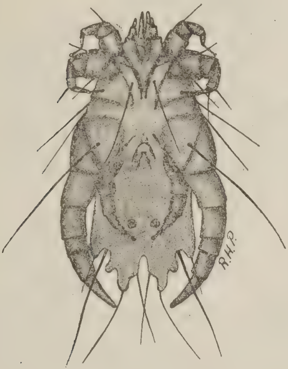


Fig. 43. Mite infesting bird, male. Greatly enlarged. Origina

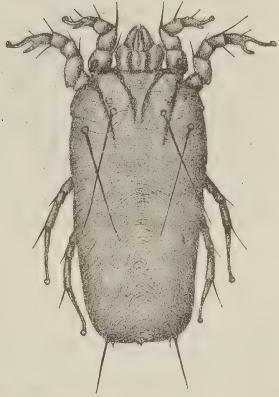


Fig. 44. Mite infesting bird, female. Greatly enlarged. Original.

There are a number of other mites, belonging to different families, which can also, in extreme cases, cause itch-like diseases. Such mites are not usually found permanently upon man and domesticated animals, but only occassionally invade them.

But it is not alone the skin of animals that is inhabited by mites; even the air-sacs of chickens are invaded by white mites large enough to be seen with the naked eye. Such parasites (*Cytodites nudus* Vizioli) enter the bronchi and may even reach the interior of air-canals in the bones. If not numerous their presence is not detected, but if favored by suitable conditions they increase rapidly in number and kill their hosts. An autopsy revealed them also in the lungs, liver, and kidney. Another species of mite (*Symplectoptes cysticola* Vizioli) causes an irritation in the connective tissues, forming tubercles, inside of which they may be found; they also occur on the abdominal viscera, in the muscles and beneath the skin.

C. HARVEST-BUGS. JIGGERS.

(*Trombidiidæ*).

These mites are soft, bright-colored, and more or less hairy. They possess a conical sucker composed of two hooked or styliform chelifers hidden in a tube formed by the lower lip and the joined maxillæ. The palpi are usually large, the second joint is longest, while the last bears a peculiar appendage which can be used as a finger and thumb. The eight legs have five or six joints, usually with two hooks. Two eyes are often present. The six-legged larvæ lead a parasitic life, and not alone upon insects and spiders, but also upon warm-blooded animals, which they torment, and where they can produce itch-like sores. The larvæ of some of the species of *Trombidium* are, however, exceedingly beneficial; for instance the young of the locust-mite check most effectually the increase of the Rocky-mountain locust. Another small and red mite is frequently found upon our common house-fly, where it becomes the torment of our tormenter. May it prosper! In figure 45 is shown a female *Trombidium* laying eggs, and a young larva; in fig. 46,

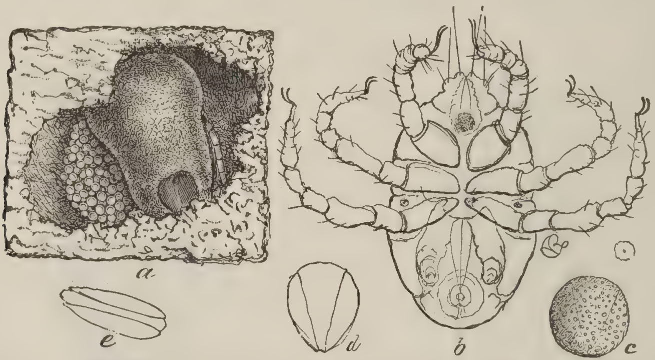


Fig. 45.—*Trombidium locustarum*; *a*, female laying eggs; *b*, young larva; *c*, fresh egg; *d*, *d*, egg shells. Enlarged. After Riley.

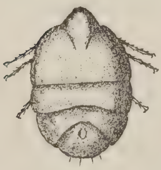


Fig. 47.—Mite from house-fly. Enlarged. Original.

plate VII, a fly upon which nine larvæ of *Trombidium muscarum* have fastened themselves; and in fig. 47 we have an enlarged illustration of one of them.

About the very worst pests of man and domesticated animals are the HARVEST-BUGS, RED-BUGS or JIGGERS, which are illustrated in fig. 48. They are barely visible mites, the young stage of a *Trombidium* not yet ascertained, of a brick-red color and are found in large numbers among low growing plants. They are not common in Minnesota, and it is to be fervently hoped will remain so forever. Men and animals, passing through low herbage that harbors them are attacked by these pests, which, whenever they suceeed in finding a host, burrow in and under the skin, causing intolerable itching and sores, the latter caused by the feverish activity of the finger-nails of the host, if that should be a man, whose energy in scratching, apparently, can not be controlled and who is bound forcibly to remove the intruders. The writer has been there! Those who have ever passed through meadows infested with red-bugs will remember the occasion.

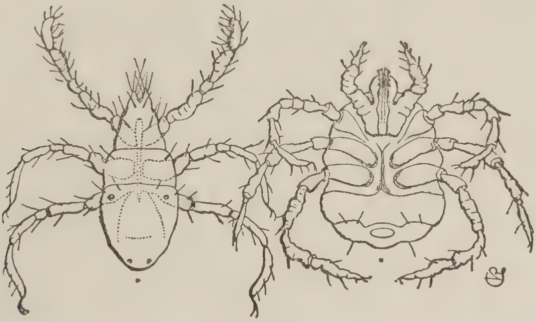


Fig. 48.—Red-bugs. The American harvest-mite at the left, the irritating harvest-mite at the right. Greatly enlarged. After Riley.

Horses and other animals in pastures suffer mainly on the lower part of the face; if kept in their stables the inflammation caused by the mites will soon disappear with the mites themselves. Dogs and cats suffer greatly in regions where such mites abound, and look as scabby and mangy as if infested by some itch-mite. Other animals do not escape, and the parasite has even been found upon the mole, field-mouse, and bat. They are most numerous late in July and during August, hence the name "Harvest-mite."

As the writer was present when the two following harvest-mites were discovered and described, when, in fact, he had to sacrifice a piece of his skin containing them for the above purpose, he will quote the describer's article in "Colman's Rural World" for June 2, 1876.

THE AMERICAN HARVEST-MITE.

(*Leptus americanus* Ril.).

"This species is barely visible to the naked eye, moves readily, and is found more frequently upon children than upon adults. It lives mostly upon the scalp and under the armpits, but is frequently found on the other parts of the body. It does not bury itself in the flesh, but simply insinuates the anterior part of its body just under the skin, thereby causing intense irritation, followed by a little red pimple. As with our common ticks, the irritation lasts only while the animal is securing itself, and its presence would afterward scarcely be noticed but for the pimple which results.

THE IRRITATING HARVEST-MITE.

(*Leptus irritans* Ril.).

"This is the most troublesome and perhaps best known of the two causing intense irritation and swelling on all parts of the body, but more especially around the legs and ankles. Woe betide the person who, after bathing in the Mississippi, or anywhere in this latitude (Missouri), is lured to some green dressing spot of grass or weeds. He may for the time consider himself fortunate in getting rid of mud and dirt, but he will afterward find, to his sorrow, that he got hold of something far more tenacious in these microscopic harvest-mites. If he has obtained a good supply of them he will in a few hours begin to suffer from severe itching, and for the next two or three days he will be likely to scratch until his limbs are sore.

"With the strong mandibles and the elbowed maxillæ, which act like arms, this mite is able to bury itself completely in the flesh, thereby causing a red swelling with a pale pustulous center, containing watery matter. If, in scratching, one is fortunate enough to remove the mite before it enters, the part soon heals. But otherwise the irritation lasts for two, three, or four days, the pustulous centre reappearing as often as it is broken.

"The animal itself, on account of its minute size, is seldom seen, and the uninitiated, when first troubled with it, are often alarmed at the symptoms, and at a loss to account for them. Fortunately, these little plagues never attach themselves to persons in such immense numbers as do sometimes young or so-called "seed" ticks; but I have known cases where, what with irritation and consequent scratching, the flesh has the appearance of being covered with ulcers; and in some localities where these pests most abound sulphur is often sprinkled in foot-gear, as a protection during "jigger" season.

"REMEDIES.—"Sulphur ointment is the best remedy against the effects of either of these mites, though, when that can not be obtained, saleratus-water or salt water will probably allay the irritation. Whether anything better than sulphur can be used as a preventive I have no real knowledge, and shall be glad to learn from those who have had experience. Any oily substance will act as a preventive, and, while kerosene is too offensive, sweet-oil might be tried. I would also recommend for trial alum-water, made by dissolving the alum in hot water, at the rate of an ounce or two to the quart.

"The normal food of these mites must, apparently, consist of the juices of plants, and the love of blood proves ruinous to those individuals which get a chance to indulge it. For, unlike the true chigoe, the female of which deposits eggs in the wound she makes, these harvest-mites have no object of the kind, and when not killed at the hands of those they torment they soon die victims to their sanguinary appetite."

THE HARVEST-BUG OF EUROPE.

"(*Leptus autumnalis*, or *Tetranychus autumnalis* Shaw).

This mite is very similar to our species. It is sometimes so numerous that crops of currants and other berries have been abandoned. These mites seem to be able to penetrate stockings and drawers, and other thin clothing, for though generally most numerous and annoying about the legs, they are found all over the body. Cats and dogs, from their prowling habits in field and garden, suffer greatly. They scratch and nip their skin with their teeth, so much so that they are sometimes supposed to be suffering from the itch, when it is only from a daily reinforcement of these mites. Fig. 49 shows a skin infested with these mites, and the imbedded heads after the removal of the parasites.

"Kirby and Spence mention a similar insect which occurs in Brazil, abounding in the rainy season, particularly during the gleams of sunshine on fine days that intervene, and which resembles a small point moving very fast. These animals they say, get upon the linen and cover it in a moment; afterward they insinuate themselves into the skin, and occasion a most intolerable itching. They are with difficulty extracted, and leave behind them large livid tumors, which subside in a day or two. An insect very tormenting to the woodcutters and settlers on the Mosquito Shore and Bay of Honduras, and called by them the "doctor," is thought to be identical with this. It is also stated on good authority that still more serious consequences have been known to follow the bite of a mite, related to the above if not the same species, common in Martinique, and called there the *bete rouge*. When the English soldiers in camp were attacked by these creatures, dangerous ulcers succeeded the symptoms just mentioned, which in several instances became so bad that the limb affected had to be amputated."

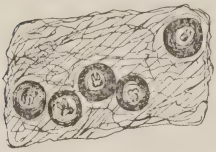


Fig. 49.—European harvest-bug. Skin of man showing imbedded heads. Enlarged. After Heller.

D. GAMASIDS.

(*Gamasidæ.*)

The species of mites belonging here are either found in damp places on the ground, or are parasitic on some animal. They possess filiform or thread-like feelers, mandibles with minute nippers, and no eyes. Their legs possess seven joints, and the tarsi have two claws with a sucker between them. Only two genera contain species that are parasitic upon domesticated animals; these are *Dermanyssus* and *Gamasus*.

THE CHICKEN-MITE OR "TICK."

(*Dermanyssus gallinæ* Redi.).

This mite infests domestic fowls, cage-birds, and not infrequently torments man and beast. In extreme cases, or when very numerous, it has even caused a form of phthiriasis, a disease otherwise caused by the presence of immense numbers of sucking-lice. Three species have been described, namely, *D. gallinæ* upon chickens, *D. avium* upon birds, and *D. hirundinis* upon swallows, but very probably they are all the same. The Bird Tick (*D. avium*) occurs in large numbers in bird cages, and is sometimes very annoying to the birds, robbing them of their sleep, and if not removed may cause their death.

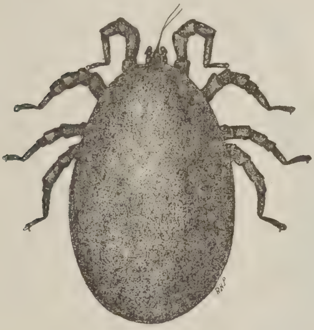


Fig. 50.—Chicken-mite or "tick." Enlarged. Original.

The so-called "tick" of chickens is very much larger than all the other mites mentioned thus far, the male measuring 0.60 by 0.20mm., the female 0.80 by 0.28mm., and the egg 0.20mm. As seen in the illustration (fig. 50) the mite possesses eight legs, of which the first two are longest, not well shown as the specimen were rather poorly mounted. The mite is either blood-red, reddish-brown or whitish, the color depending largely upon the last meal consumed. Chicken-mites of this kind are most abundantly found in hen-manure, or behind the frame-work of the hen-house. Large numbers breed and hide in the nest of chickens, and if an egg should be broken in such a place it is soon covered with myriads of them. They occur also in bird-cages, pigeon-houses, and nests of swallows or other birds. They attack also the skin of man, horse, dog, cats, and other animals, where they cause great irritation, sores, and scabs, and cases are known where they have settled permanently upon birds, chiefly pigeons, and upon the cat, killing these animals in course of time. As they are nocturnal in their habits they are not often found upon the tormented animals during the day, but as soon as it becomes dark they leave their hiding-places to suck blood. They obtain this by means of very keen mandibles, and if at all numerous they extract considerable quantities of it and thus become very injurious, even fatal to younger or weaker birds. Even when not very numerous they prevent the fowls from sleeping at night, and not infrequently force setting hens to leave the eggs. They have also been known to enter the nasal cavities of birds, causing a severe inflammation.

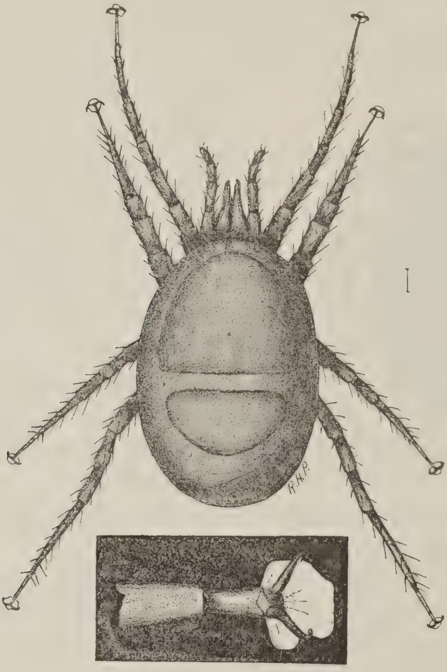


Fig. 51.—*Gamasus* spec. Mite and leg greatly enlarged. Original.

Remedies.—Cleanliness is always the best preventive. The houses and cages must be washed from time to time with hot water; the perches should be solid, so as to offer no hiding places. In bird-cages it is best, however, to use hollow perches, which act as traps in which the mites congregate during the day, and from which they can readily be removed by boiling water. There are a number of other remedies, such as the use of insecticidal powders, lime-wash, kerosene-emulsion or kerosene alone, sulphuret of carbon, creolin and others. But no matter which of these substances are used they have to be applied frequently and most thoroughly as the mites can remain hidden without food for many months. In one case specimens were kept for ten months in a glass without food, and the mites, though very feeble, were still living. Hen manure, swarming with such dangerous foes to the sleep and rest of all domesticated animals, has to be removed from stables, or the inhabitants will be infested; in fact poultry-houses should always be isolated.

The *Gamasus* shown in fig. 51 was found in large numbers in a neglected hen-house, and greatly tormented the inhabitants. It took a long time and many applications of kerosene to dislodge it.

Prof. Leidy described in 1872 a mite found in the ear of a bull. Many specimens were discovered upon the ear-drum, and hence received the name of *Gamasus auris.* Mr. Turnbull found them repeatedly in similar situations and believes this mite to be a genuine parasite.

Other mites, as *Gamasus pteropteroides*, which normally are found only in musty fodder, occasionally also reach our domesticated animals and cause all sorts of irritations. Still others, for instance those found in old flour, cheese, dried plums and figs, have been detected repeatedly in sores upon horses and in other places. To show the general appearance of such mites one of the cheese-mites (*Tyroglyphus longior* Gervais) has been illustrated in fig. 52. This mite, common enough in houses, enjoyed for some time the ephemeral fame of being a human creation, as it was claimed to have been produced by subjecting a volcanic stone, kept moist with a weak solution of silicate of potash, to a continuous current of electricity. This mite, if eaten with cheese, can also cause sickness. Whenever fodder spoils mites are sure to be found in immense numbers, and as they are equipped with all kinds of tools to reduce the fodder to dust, and as such spoiled material is only found in stables not well cared for, it is not so very strange that animals forced to live in such places will soon show the presence of such mites by their restlessness and scabby appearance.

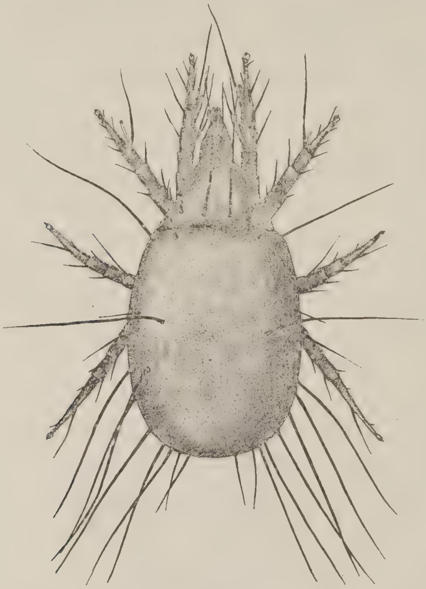


Fig. 52.—*Tyroglyphus longior* Gervais.
Greatly enlarged. Original.

Unrefined sugar sometimes swarms with minute mites (*Tyroglyphus* (*Acarus*) *sacchari*) and Mr. Cameron of Dublin counted five hundred of them in ten grains of sugar, which means that one pound of sugar harbored more than one hundred thousand of these minute beings (fig. 53). This is a decidedly bad case of adulteration! The disease known as "grocer's itch" is said to be caused by the presence of such mites, which, like the true itch-mites, burrow under the skin of the hands of persons frequently handling such sugar.

Dr. Packard received a peculiar Cheletus-like mite (fig. 54 shows an allied species) from New Orleans, said to have been extracted from the human face. "Its body is oblong and square behind; the head is long and pointed, while the maxillæ end in a long, curved, toothed, sickle-like blade. That this creature has the habits of the itch-mite is suggested by the curious, large, hair-like spines with which the body and legs are sparsely armed, some being nearly half as long as the body. These hairs are covered with very fine spinules. Those on the end of the body are regularly spoon-shaped. These strange hairs which are thickest on the legs, probably assisted the mite in anchoring itself in the skin of the host."

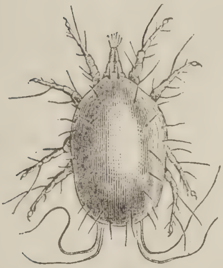


Fig. 53.—*Tyroglyphus* (*Acarus*) *sacchari.* Greatly enlarged. After Packard.

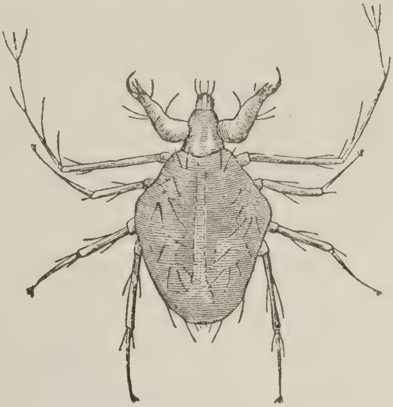


Fig. 54.— *Cheletus* spec. Greatly enlarged. After Packard.

It is quite certain that a number of other mites belonging to various families can exist, for some time at least, upon the skin of man and domesticated animals, and these mites need not necessarily be blood-sucking species. For instance *Crithoptes monunguiculosus* has been found in Germany to be the cause of an endemic disease attacking some laborers who were loading barley containing such immature six-legged and dark-red mites. Another mite, *Cheletus,* was found in the pus coming from the ear of a sailor.

E. TICKS.

(*Ixodidæ.*)

The ticks or wood-ticks are well known to all people that live near uncultivated land, and to hunters and others that are in the habit of visiting forests. They all have learned that these parasites can be very troublesome to man and beast. They hide among bushes and other low plants, and holding themselves with some of their legs to blades of tall grasses, perhaps overhanging a path, they stretch out the other legs at full length to detect any animal that may happen to pass that way and to which they attach themselves. Once fastened they select a suitable spot to insert their peculiar sucking-organs for the purpose of securing a feast of blood. All ticks are parasitic, infesting chiefly mammals and reptiles, but also birds.

Their body is round or broadly oval, very flat, and protected by an exceedingly tough integument. When swollen with blood their legs, which appeared very long in the hungry creature, are now almost useless, and the tick in this shape resembles very closely a castor-oil bean. When the brute has reached its acme of happiness, fullness, it withdraws the sucking-organs and drops to the ground. Fig. 55, plate IX, shows ticks of various sizes just removed from a dog.

The mandibles (fig. 56) are covered with teeth and have terminal hooks; their maxillæ are small, not reaching beyond the beak, but bear a peculiar organ called the glossoid, which is also covered with hooks. Their slender, seven-jointed legs have two claws, and those of the six-legged young mites, pads or suckers. These parasites crowd together in large numbers when still young, clinging like the mature ticks to the tips of leaves, with a number of their slender legs extended, and wait for "something to turn up." When they succeed in reaching a victim they insert their glossoids and mandibles into the skin, to which they cling very firmly by means of the numerous hooks. This operation causes considerable irritation. If pulled out violently, these sucking-organs and the head remain in the skin and cause bad sores. To remove the entire animal, we have to apply oil; as soon as the parasite is touched with this substance it will withdraw the imbedded proboscis. Animals upon which large numbers of ticks are fastened can be relieved by means of kerosene-emulsion.

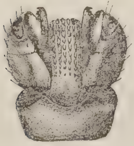


Fig. 56. Mouthparts of common tick. Enlarged. Origina .

The eggs of the ticks are deposited in large masses during May and June; they hatch early in July, the "shell opening like a clam."

Ticks are quite numerous in Minnesota, but only in the south do they become extremely troublesome to persons and animals.

THE CATTLE-TICK.

(*Boophilus bovis* Ril.).

This is a flat, leathery, reddish and seed-like species with an oblong oval body (fig. 57). When mature it reaches nearly half an inch in length. It does not occur in Minnesota, but is a southern and, originally, a tropical species which is annually killed by frost north of the Ohio and Potomac rivers. Generally speaking, the injury caused by this gigantic mite, sucking the blood of animals, would be but small, if it were not for the fact that it is the chief and perhaps the only agent that spreads the "Texas Fever" or "Red Water." This disease is caused by a microbe which enters the veins and arteries of cattle and rapidly and extensively destroys the red corpuscles of the blood. The cattle-tick, which sucks

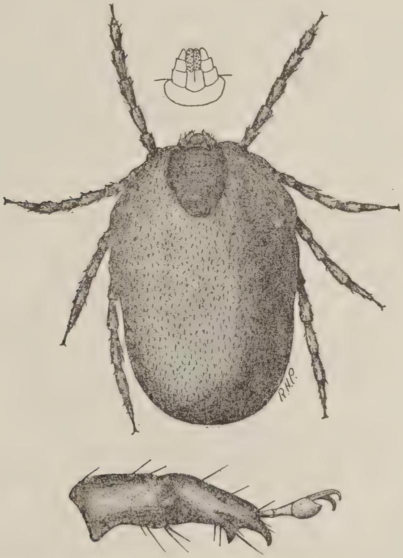


Fig. 57.—Cattle-tick. Enlarged. Original,

the blood of diseased cattle, conveys the disease-germs to its young, which carry it to other cattle invaded by them. In the region south of the two rivers mentioned above, the disease is seldom fatal to the native stock, in the blood of which it always seems to exist; at least it can be artificially inoculated from apparently healthy southern cattle into healthy northern stock. If native cattle are brought from the northern regions into the permanently infected region they are almost certain to contract the disease if permitted to run at large. Younger cattle may be acclimated and not catch the disease in its dangerous form. If southern cattle, carrying with them such ticks, are sent north, the latter drop off when mature and deposit eggs upon the soil of the pastures, stables and yards; the young ticks, hatching in eighteen to twenty-four days, thus reach other stock and as they carry with them the microbe causing the disease and as they are not slow to bite, they convey this disease, which in from two to three weeks developes into Texas fever. All these interesting facts were discovered by the careful investigations made by the U. S. Department of Agriculture.

REMEDIES.—Though we do not find this dangerous tick in Minnesota it is well to know the proper treatment, especially as this is equally effective against the ticks found here. Pine tar, one gallon; kerosene, fish-oil or crude carbolic acid, one quart; and powdered sulphur, two pounds, should be thoroughly mixed. This makes an excellent salve for sores, and will also protect animals against flies; as a protection fish-oil is better than either kerosene or carbolic acid. The salve should be thoroughly rubbed in, and this operation should be repeated from time to time.

THE COMMON TICK.

(*Dermacentor americanus* L.).

This tick is the only one that is common in our state, and very common in some localities. It is found especially numerous upon hunting-dogs. As very little seemed to be known about the life-history of this tick some full-grown specimens, swollen with eggs, were put in a moist-chamber. They were not slow in depositing immense numbers of eggs,

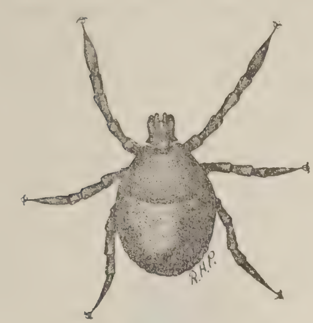


Fig. 61.—Young tick. Enlarged. Original.

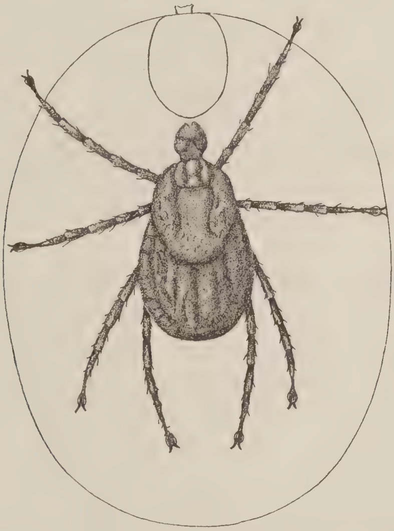


Fig. 62.—Common tick before and after a meal. Greatly enlarged. Original.

(fig. 58, plate IX) which seemed to issue from the wrong end of the animal. By looking at fig. 59, plate IX, it will be seen that the opening of the sexual organs, *b*, is situated between the haunches of the first pair of legs, and close to the mouth. Many thousands of eggs were laid by each female, which hatched in the course of three or four weeks. The young ticks remained for some time huddled together (fig. 60, plate IX) and appear enlarged, as in fig. 61. They show already upon the margin of the abdomen plates of chitin which enable them to greatly expand with food. Male and female ticks are shown in fig. 55, plate IX, just as they were removed from a dog. The mouth-parts of this species, described before, are shown in fig. 56, and the illustration (fig. 62) shows the tick before and after a meal. The outline of the tick filled with blood is simply indicated by a line enclosing a still hungry parasite.

As the dogs infested with such ticks generally drop them in and near their sleeping places, these become soon badly invaded with the small and hungry ticks, sometimes called "seed-ticks," and in this case they greatly torment the animals in the vicinity of such breeding places. A thorough and repeated spraying with kerosene oil will kill these pests. The ticks were also found upon horses and other mammals, and even upon a rattlesnake.

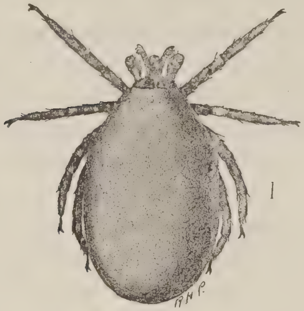


Fig. 63.— Tick from Pocket-gopher, adult. Enlarged. Original.

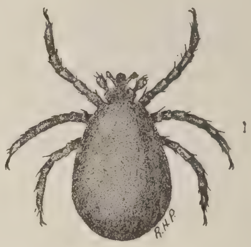


Fig. 64.—Tick from Pocket-gopher, young. Enlarged. Original.

Many other species occur in Minnesota. Some are quite small, as the one upon the pocket-gopher illustrated in figs. 63 and 64, which shows the adult and the young six-legged larva.

All the parasites described thus far are not true insects, differing from them by the possession of eight legs when mature, by never possessing any wings, and by numerous other characters not necessary to mention in this place.

F. SUCKING-LICE.

(*Pediculi.*)

This family of insects includes a number of unsavory parasites that infest man and quadrupeds. Though those attacking man are not usually mentioned in polite society it is sometimes not only important to describe them, but even necessary to give remedies to reduce their numbers. Of course the time has passed when insects of this or of a similar character were such a common occurence that few school rooms could boast of not having such inhabitants. It shows that civilization after all depends largely upon the free use of soap and some mechanical appliances as fine-toothed combs.

Lice are true insects furnished with a sucking mouth (fig. 65). They are very degraded insects, however, and do not even possess wings, for which they have no use, being generally surrounded in their dwelling-places by plenty of food. The small head is conical; the thorax is also small and indistinctly segmented; the abdomen, however, is large, flat, round or oval, and contains nine segments. The slender feelers possess five joints; the simple eyes, if they possess any, are minute; the feet have two joints, of which the last one forms a strong hook for grasping the hairs while climbing upon them. The mouth forms a very slender, fleshy

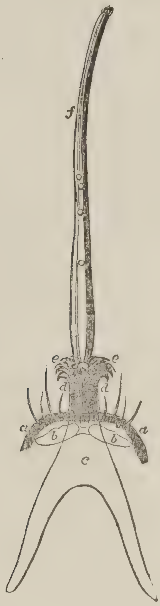


Fig. 65.—Mouth-parts of body-louse; *a*, *a*, summit of head with bristles; *b*, *b*, the chitonous band; *c*, hind part of lower lip; *d*, *d*. protruding part of lower lip (*haustellum*); *e*, *e*, hooks turned outwards; *f*, inner tube of suction, with two pairs of jaws shown as lines on the outside, and a few drops of blood in the interior. Greatly enlarged. After Schiœdte.

tube, which is retracted if not in use; inside this tube is a fine bristle-like organ which can be introduced into the skin for the purpose of sucking blood. According to Schiœdte it has the following construction: "the peculiar attenuation of the head in front of the antennæ at once suggests to the practiced eye the existence of a mouth adapted for suction. The mouth differs from that of Rhynchota (as bed-bugs, etc.) generally, in the circumstance that the labium is capable of being retracted into the upper part of the head, which therefore presents a little fold which is extended when the labium is protruded. In order to strengthen this part, a flat band of chitine is placed on the under surface, just as a shoemaker puts a small piece of gutta-percha into the back of an india-rubber shoe; as, however, the chitine is not very elastic, this band is rather thinner in the middle, in order that it may bend and fold a little when the skin is not extended by the lower lip. The latter consists, as usual, of two hard lateral pieces, of which the fore ends are united by a membrane so that they form a tube, of which the interior covering is a continuation of the elastic membrane in the top of the head; inside its orifice there are a number of small hooks, which assume different positions according to the degree of protrusion; if this is at its highest point the orifice is turned inside out, like a collar, whereby the small hooks are directed backwards, so that they can serve as barbs. These are the movements which the animal executes after having first inserted the labium through a sweat-pore. When the hooks have got a firm hold, the first pair of setæ (the real mandibles transformed) are protruded; these are, towards the points, united by a membrane so as to form a closed tube from which, again, is exserted the second pair of setæ, or maxillæ, which in the same manner are transformed into a tube ending in four small lobes placed crosswise. It follows that when the whole instrument is exserted, we perceive a long membraneous, flexible tube hanging down from the labium, and along the walls of this tube the setiform mandibles and maxillæ in the shape of long narrow bands of chitine. In this way the tube of suction can be made longer or shorter as required, and easily adjusted to the thickness of the skin in the particular place where the animal is sucking, whereby access to the capillary system is secured at any part of the body. It is apparent, from the whole sttucture of the instrument, that it is by no means calculated for being used as a sting, but is rather to be compared to a delicate elastic probe, in the use of which the terminal lobes probably serve as feelers. As soon as the capillary system is reached, the blood will at once flow in the narrow tube, after which the current is continued with increasing rapidity by means of the pulsation of the pumping ventricle and the powerful peristaltic movement of the digestive tube."

All true lice have very similar habits, all are bloodsuckers, but each species inhabits only a certain kind of animal, some are even restricted to certain parts of the skin. Some animals harbor several species, and five kinds are stated to be found upon man, three of which are common enough under certain conditions.

Whenever lice become very abundant by negligence they cause great irritation to the skin of their host. Animals thus invaded try to overcome this constant itching by rubbing themselving against fences, trees, and buildings, and soon wear off their hair and injure their skins. In time lousy animals become weak and otherwise diseased.

THE HEAD-LOUSE OF MAN.

(*Pediculus capitis* De Geer).

This kind is probably the best known of all species, and but few young children in our public schools have had no opportunity to observe their actions. Of course the presence of such parasites is an indication, nay, a proof, that personal cleanliness is sadly neglected. The old belief that these parasites were indications of healthy blood is not true, and it should surely be no longer fashionable to be thus tenanted, as it used to be in old times and in some countries. This parasite is confined to the human head, and only in extreme cases does it spread over the whole body.

All races of man are infested, and Kuechenmeister reports that he even found the eggs of this species in the hairs of a

Peruvian mummy. The lice infesting the heads of negroes are darker, but among caucasians also colored varieties are not uncommon.

This louse (fig. 66) is too well known to require a detailed description; the male is 1 to 1.5mm. long, the female almost 2mm. The white eggs or "nits," 0.6mm. long, are elongated oval, with several little conical prominences at their large ends, which are open at the top, while the small end bears a cluster of bristles. About fifty eggs are glued at their pointed ends to hairs; in about six days the young hatch, grow rapidly, and after shedding their skins three times reach their adult condition in about three weeks. The young lice resemble the adult ones except in size; they are also less distinctly marked. The belief often expressed that a female louse could become a grandmother in the course of twenty-four hours is of course absurd.

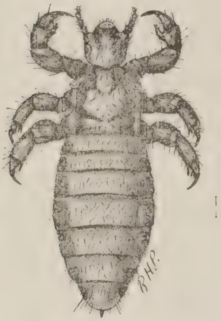


Fig. 66.—Head-louse of man. Greatly enlarged. Original.

As the habits of these parasites are so well known, and the treatment of getting rid of them is familiar to those most interested in such matters, it is needless to mention them. Cleanliness and the application of hair-oils, etc., are good preventive measures. A little benzine is deadly for such intruders, but being very inflammable it should not be applied when near a light or fire, otherwise the hairs with their inhabitants might be removed. Sulphur ointment and white precipitate are also well-known remedies against these insects.

THE BODY-LOUSE OF MAN.

(*Pediculus vestimenti* Leach).

This species has received a number of names on account of some fancied peculiarities. They closely resemble the head-louse but are larger, the female measuring as much as 2mm. to 4mm. The smaller males are not as numerous as the females. The eggs, 0.8 to 1.0mm. long, 0.8mm. broad, are attached to the clothing, especially along the seams where these come in contact with the human body. From about 60 to 70 eggs are deposited by each female. During the warmer part of the year these lice can increase very rapidly in numbers, and Leeuwenhoek has estimated that a single adult female could have in eight weeks a progeny of 5000. This rapid increase accounts for the many authentic accounts of their sudden appearance. A disease, mentioned by the very earliest writers, the *Phthiriasis*, was stated to be caused by lice and it seems probable that this is the species referred to. These parasites prefer the less hairy parts of the body, as the neck, back, and abdomen, where they can cause a sort of eruption; or they simply redden the skin in larger or smaller spots, which, on account of the constant scratching induced by the itching presence of the insect, become sores. Fig. 67 shows this nasty parasite.

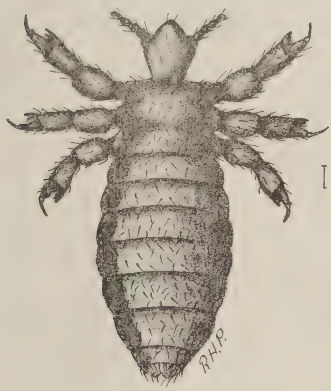


Fig. 67.—Body-louse of man. Greatly enlarged. Original.

In cases in which the clothing is seldom changed, as is usually the case in armies during war, these insects, frequently called "Grey-backs," increase very rapidly in numbers and become a great source of annoyance. Many, if not most of our veterans can tell wonderful stories about these parasites; in fact some yarns have been told about them that require a very strong constitution to stand the strain in believing them. These lice become also very numerous in lumber-camps and other places where bathing and a frequent change of clothing are out of the question. Persons forced to live for a long time in camps can only protect themselves against these unpleasant intruders by cleanliness, and by changing their underwear as frequently as possible. The parasites in soiled clothing are readily killed by boiling or baking it.

THE CRAB-LOUSE.

(*Phthirius inguinalis* or *pubis* Leach).

This parasitic insect belongs to a different genus of lice, as can be seen by its heart-shaped form and broad thorax, which is not separated from the abdomen (fig. 68). The former is composed of two segments soldered together, the latter of eight flat joints. The first pair of legs are feeler-like and possess slender tarsi; the claws of the two other pairs are large and strong, with a moveable thorn, to enable the insect to secure a strong hold upon the hairs. The head, broad in front, carries five-jointed feelers, and behind them, upon two projections, the two simple eyes. The end of the abdomen in the male is rounded, that of the female is bi-lobed. Owing to the peculiar shape, the strong legs spreading out laterally, this louse resembles a minute crab, hence the name "crab-louse." It is of a whitish color, with a dusky ill-defined spot upon each shoulder; the legs are reddish, with darker claws. The male measures 1mm. in length, the female 1.2mm. The pear-shaped eggs (fig. 69), 0.9mm. long and 0.5mm. wide, are glued at their pointed ends to hairs; about ten eggs are deposited.

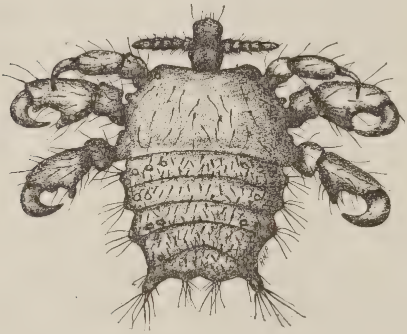


Fig. 68.—Crab-louse of man. Greatly enlarged. Original.

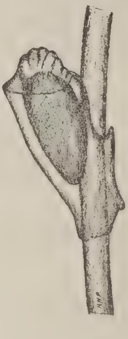


Fig. 69.—Crab-louse of man, egg. Greatly enlarged. Original.

This species lives among the hairs of the pubic regions of man, and, also, though not very frequently, upon the breast, arm-pits, even in the beard, eye-brows and on the head. As these nasty parasites cling frequently to linen and other clothing, they occur even in closets of hotels, depots, and similar much-frequented places.

If these lice occur only in few numbers they simply cause a violent itching; if large numbers are found together they can cause a sort of scab, a consequence of the continuous scratchings by the infested person.

They can be destroyed by simple ointments, emulsions of etherial oils, by unguents, or by the sulphuret washes already mentioned. Red precipitate is most frequently used.

This louse, as well as the body-louse, had formerly a very bad reputation, and judging from numerous accounts given in old publications they caused a fearful disease, the Phthiriasis. According to history Herodes, Philipp II. of Spain, Max. I. of Germany, and other persons, died from this disease, but in more recent times no authentic cases have been observed.

All true lice which infest our domesticated animals have been placed in another genus of lice, for very insufficient reasons, however, as they vary but little from those infesting man. The generic characteristics of the genus Hæmatopinus are: head obtuse or truncated in front, the middle segments of the abdomen well separated, and the posterior legs much the longer. Eyes very minute or absent. Lice of this genus have the same habits as those found upon man, and are most abundant upon neglected animals, or upon animals that have been for a long time confined in stables.

THE HOG-LOUSE.

(*Hæmatopinus urius* Nitzsch).

This is the largest louse known, measuring from 3 to 4.5mm. (one-quarter of an inch) in length. Its color is brown, yellowish-brown, or yellow, with a whitish abdomen. The margin of the head is dark-brown, and each joint of the feeler possesses in the middle a dark ring. A brown, six-cornered spot is usually found upon the under-side of the thorax; the legs are also ornamented with brown rings, and the claws are quite dark. The spiracles are placed in blackish. horny plates along the sides of the abdomen.

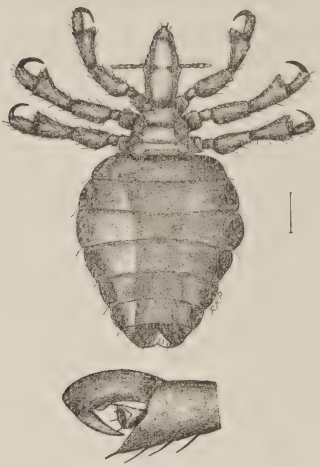


Fig. 70.—Hog-louse. Greatly enlarged. Original.

The louse is sometimes very abundant upon hogs, preferring as a home the thighs.

Fig. 70 shows this nasty insect. Its claw and tibial tooth, which act as finger and thumb, and enable the louse to walk quite well, are also shown.

THE HORSE-LOUSE.

(*Hæmatopinus asini* Linn. (*macrocephalus* Burm.).

This parasite is found upon the horse and ass; it is distinguished by a very narrow and elongated head, and by possessing a triangular indentation behind each feeler. In this indentation is located the eye. The abdomen is short and oval, and the segments are deeply dentated at the margin; the whole abdomen is but a little longer than the rest of the body. Color yellowish or rust-colored; the thorax brownish, at base of feelers a triangular black spot. Front of head, claws and horny plates surrounding the spiracles are dark brown. Length 2 to 3.25mm. These lice infest chiefly the throat and neck of their hosts (fig. 71, plate VI).

THE SHORT-NOSED CATTLE-LOUSE.

(*Hæmatopinus eurysternus* Nitzsch).

This common parasite of our cattle is 1.5mm. long. Its head is bluntly rounded in front, and broadest behind the feelers which are as long as the head. Eyes very small and difficult to detect. The thorax is very broad, much broader than long, and widest where it joins the abdomen. The head, which is wedge-shaped behind, fits into a triangular indentation of the anterior margin of the thorax, the abdomen is strongly segmented. The louse is light-brown; the posterior half of head, the thorax and legs are darker; the abdomen bluish-gray. The elongate oval eggs tapering at the lower end, and having a cap-like lid at the upper end, are deposited on the hairs close to the skin. Fig. 72 shows the male louse with enlarged tip of abdomen seen from below, and fig. 73 the corresponding part of a female and an egg fastened to the hair of a cow.

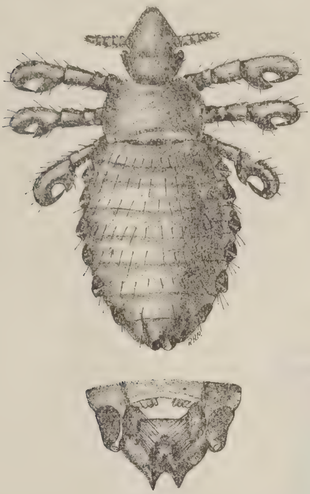


Fig. 72.–Short-nosed cattle-louse; male, and tip of abdomen from below. Greatly enlarged. Original.

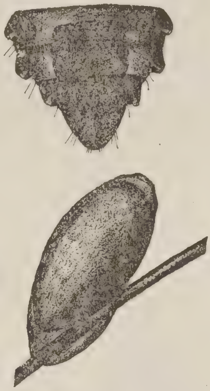


Fig. 73.—Short-nosed cattle-louse; female abdomen from below, and egg. Greatly enlarged. Original,

This parasite is especially troublesome on the neck and shoulders of the infested animals, and these parts are frequently worn bare of hair by efforts to dislodge the irritating intruder.

It is not easily dislodged if once settled in large numbers upon an animal. Veterinarians seem to prefer Stavesacre as a remedy. Kerosene-emulsion, or even a mixture of kero sene and soft soap, well rubbed in, will quickly and thoroughly kill these intruders.

THE LONG-NOSED CATTLE-LOUSE.

(*Hæmatopinus vituli* Linn).

This parasite (fig. 74) possesses a long and narrow body, measuring 2 to 2.30mm. The small head, pointed in front, shows very plainly the long and projecting beak. A very small eye is found behind each feeler. The head is wedged into a squarish thorax. The legs are not of the same length, increasing in length from the first to the third pair. The abdomen is long and narrow, almost spindle-shaped, not sharply segmented, and lacks the chitinous plates along the sides. The head and thorax are brown, the abdomen bluish-gray, the legs brown, darker at the tips.

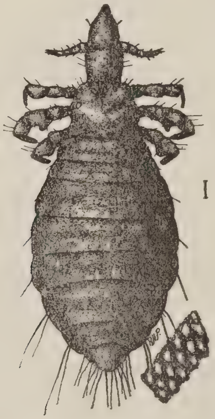


Fig. 74.—Long-nosed cattle-louse. Greatly enlarged. Original.

THE GOAT-LOUSE.

(*Hæmatopinus stenopsis* Burm.).

This insect possesses a long head with a wedge-like and pointed basal end. The feelers are shorter than the head, the thorax is square, the legs short, with strong and heavy claws. Head and thorax brownish-yellow, end of feet brown, abdomen grayish-white or grayish-yellow. It measures

2.25mm., and is found upon the goat. This species has not been found in Minnesota as goats are not numerous in our state.

THE SHEEP-LOUSE.

(*Hæmatopinus ovis* n. sp.).

It seems that no sucking-lice have been found upon the sheep, at least none have been described as far as the writer has been able to discover. While looking for other parasites upon this animal Mr. R. H. Pettit discovered a sheep that had the hind-legs badly infested by a louse. Those parts covered by hair or short wool were chiefly invaded, though some lice were found higher up in the wool. During the colder days in December the lice also invaded other parts of the sheep, still preferring, however, the legs, quarters and shoulders. The work of these parasites had been noticed some six months previous to their discovery, and they had during all this time not extended the region invaded, nor had they spread to other sheep. This would almost indicate that this louse was out of place upon sheep. This species is on that account less to be feared than the others already described. Yet they had increased in the invaded region in immense numbers, which makes it still more remarkable that they did not wander to the other

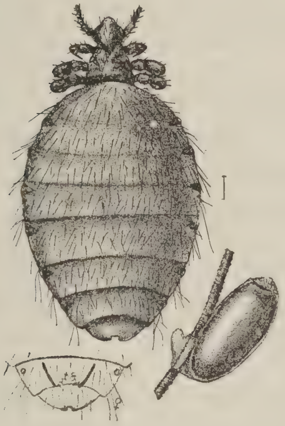


Fig. 75.–Sheep-louse; female and gg. Greatly enlarged. Original.

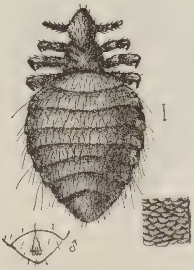


Fig 76. — Sheep-louse, male. Greatly enlarged. Original.

sheep confined in the same pen. The effect of the presence of such multitudes of irritating lice was plainly seen by the poor condition of the sheep, and by its restlessness. The illustrations (figs. 75 and 76) show both sexes, and one of the eggs. The entire skin of this louse is beautifully chagreened, as indicated in the illustration.

THE DOG-LOUSE.

(*Hæmatopinus piliferus* Burm.).

This extremely troublesome louse seems to defy all attempts to dislodge it from its host, the dog; at all events it is no easy matter to free dogs once infested by these unpleasant guests. The louse is about 2mm. long with a six-sided head and thick feelers. The thorax shows divisions into segments and is trapezoidal in shape. The large abdomen has segments not strongly marked. The underside of the parasite is closely covered with hairs and minute eminences, which are fewer in numbers upon the dorsal surface. Legs are about equal in length and thickness. Head and thorax yellow or brownish-yellow, abdomen yellowish-brown or light yellow. Fig. 77.

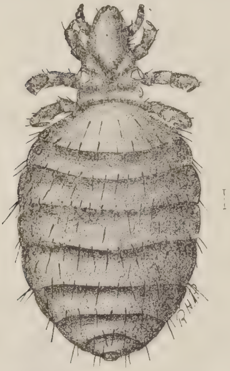


Fig. 77.–Dog-louse. Greatly enlarged. Original.

The skin of this louse is quite transparent, so that the food consumed can be detected in the intestines.

Remedies.—All lice infesting our domesticated animals should be removed as soon as detected, as animals harboring such blood-sucking and irritating guests become restless and weak. There are many remedies that can be used. White precipitate or ammoniated chloride of mercury, used as an ointment and well rubbed in, is an excellent remedy for this purpose. Being very poisonous, the dog has to be muzzled, and the substance has to be washed off with soap and water after a few days or when no longer required. A very weak solution of nitric acid is stated to be also a good liquid remedy.

Tobacco-tea.—This tea, made of one part common tobacco boiled in 20 to 25 parts of water, or in 20 parts of water and 10 parts of vinegar, is a very good wash to kill lice on dogs and sheep; it should not be used against those infesting horses or cattle, as these animals are very sensitive to the use of this remedy.

Gray mercurial ointment should only be used against lice infesting horses and hogs; cattle are injured by this poison, and it should only be applied to the parts of the skin invaded by the parasites.

Persian insect-powder.—This powder, if fresh, is a very excellent remedy. It should be applied to the skins after they have been moistened slightly so that it will stick.

Benzine.—1 part to 4 parts of soft-soap and 10 to 15 parts of water will kill most lice.

Kerosene-emulsion, to which may be added an extract of Persian insect-powder, is one of the best remedies known. If no emulsion can be made we have a good remedy by mixing 3 to 6 parts of linseed oil with one part of kerosene oil.

Carbolic acid.—Very dilute solutions of this substance in water make a fairly good wash.

Raw linseed-oil.—This will readily kill the lice infesting the hog. If none of these mixtures or ointments should help, *Arsenious Acid* will surely do so, though being a very poisonous substance it is not wise to use it except in extreme cases. A good proportion is the following one: dissolve 16 gr. of white arsenic and 16 gr. of potash each in 1½ kg. water, and add to the mixture of both 1½ kg. vinegar.

No matter which of the above remedies we may apply it is always necessary to use them at least twice within an interval of 5 to 7 days. This is required so as to kill the young lice hatching from the eggs or "nits". The latter can be readily killed by vinegar.

Cleanliness is all important. To simply comb and brush our domesticated animals, if time permits, is not the true way of treating them. Besides sufficient food they should be cleaned at least once every day.

G. FEATHER OR HAIR-LICE.

(*Mallophaga*).

These insects have been shifted about in classification from one place to another. At one time they were associated with true lice; later they were considered members of the orders of *Orthoptera* and *Neuroptera*, or allied to the white-ants, book-lice and similiar insects. At present they have been elevated to the position of forming an independent order, the *Mallophaga*. From the above it will be seen that they do not merely cause a restless condition to their hosts! Nor is it strange that they are not easily placed in a classification when we consider that these insects lead a parasitic life, and have their whole organization modified for this purpose.

Feather-lice have an incomplete metamorphosis. They are produced from whitish, elongate-oval eggs, which are fastened with some sticky substance to the bars or vanes of feathers. The eggs are furnished with a circular lid at the larger end, which is pushed off by the hatching young. It seems to require several weeks before such eggs will hatch. How many are laid by a female is not known, but not very many, as the eggs are very large for the size of the parent. The writer saw upon several occasions such eggs deposited by lice removed from their host; the former were kept in a warm place about his person, but would not hatch. The young lice are always white, without any markings or chitinous bands.

The adults possess a small, flat, and very tough body, and there are no traces of wings. The peculiarly shaped horizontal head is very large in proportion, flat and usually sparsely haired. The mouth-parts (fig. 83) are located below the head; the antennæ are short, 3, 4, or 5 jointed. The very large clypeus forms the principal part of the head, and is prolonged into a more or less colored plate. The simple eyes are located behind the antennæ. The biting mouth-parts are difficult to study. The legs are strong, and the shorter first pair is used to carry food to the mouth. The abdomen is flat, short, oval to long and slender, and differs frequently very much in the sexes.

The food of these parasites, which possess a biting and not, like true lice, a sucking mouth, consists of epidermal cells and minute particles of hairs and feathers. If they are very numerous they cause their host a great deal of inconvenience and real injury. This is almost entirely caused by their sharp claws, which irritate the host, thus making rest impossible, and not so much by any abstraction of food, as has frequently been claimed. The ear-shaped crop of these parasites, filled with food, and located in the abdomen, has been dissected again and again, but no blood could be found.

These insects remain for life upon the body of their hosts, though some, like the common louse of the hen (*Menopon pallidum*), are sometimes found walking upon the roosts. Yet they are by no means stationary, but move about so rapidly among the feathers and hairs that they are not readily captured. In this manner they can reach, by actual emigration, other birds of their kind, since these usually associate together. Birds, infested by such lice, though they would furnish the same amount of food after death as before, are still no longer suitable abodes for these parasites, for they require not only food but warm shelters. This is the reason why dead game-birds and poultry are sometimes such unpleasant objects to handle, as the lice are leaving them for warm places, very much to the disgust of cooks and taxidermists.

The order *Mallophaga* is divided into the two sub-orders *Ischnocera* and *Amblycera*; insects belonging to the former have three to five-jointed, filiform feelers and no labial palpi; those belonging to the latter have club-shaped, four-jointed feelers and four-jointed labial palpi. Of the feather-lice found upon domesticated animals and birds in Minnesota the following genera: *Trichodectes*, *Docophorus*, *Goniodes*, *Goniocotes* and *Ornithobius* belong to the *Ischnocera*, and *Calpocephalum*, *Trinotum* and *Menopon* to the *Amblicera*. To avoid unnecessary repetition of technical details these parasites have been arranged according to the hosts they infest, and not according to a scientific classification.

We will first describe the hair-lice found only upon our domesticated animals. All belong to the genus *Trichodectes;*

and the parasites belonging here are characterized by possessing three-jointed feelers, while all others have five-jointed ones.

THE BITING-LOUSE OF THE DOG.

(*Trichodectes latus* Nitzsch).

This parasite is found not very commonly upon our dogs. It shows, apparently, a preference for puppies, and is said to migrate from older to younger hosts in large numbers when opportunity offers. Its hairy head is large, almost square, but slightly rounded in front, and of a dark yellow color, with four brown marginal spots. The three-jointed feelers are inserted in a depression, behind which is a dark spot. The thorax is composed of two joints of equal length, of which the former is the narrower. The legs are of equal length, thick, with a strongly curved claw upon each tarsus. The ten-jointed, elongated-oval abdomen is covered with bristles, and is light yellow; the thorax is darker. Length 1 to 1.5mm., seldom 2mm. Fig. 78 is copied from Nitzsch's *Insecta epizoa*, edited by Giebel.

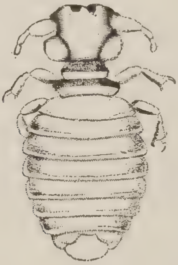


Fig. 78.—Biting louse of dog. Greatly enlarged. After Nitzsch.

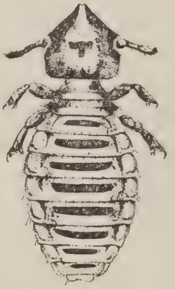


Fig. 79.—Biting-louse of cat. Greatly enlarged. Original. After Nitzsch.

The early stage of a tape-worm (*Tænia cucumerina* or *Dipylidium caninum* L.) occurs in this louse. The dog, by crushing this source of irritation with the teeth, can thus directly become infected by this tape-worm.

THE BITING-LOUSE OF THE CAT.

(*Trichodectes subrostratus* Nitzsch).

Our domesticated cat is sometimes infested with these parasites. The insect is 1.2mm. long and is distinguished from species found upon other mammals by its pointed head. Below the front of the head is found a deep furrow, into which fits a hair of the host so closely that it can not be readily removed. Fig. 79 from *Insecta Epizoa* shows this parasite.

THE BITING-LOUSE OF THE SHEEP.

(*Trichodectes sphærocephalus* Nitzsch).

This louse is distinguished by an almost circular, hairy, and yellow head, with darker margins in front of the feelers.

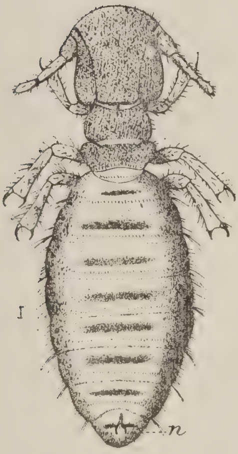
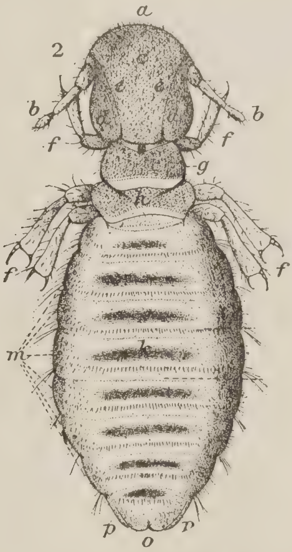


Fig. 80. — Biting-louse of sheep, male; *n*, genital orifice. Greatly enlarged. After Curtice.



Fig, 81.—Biting louse of sheep, female; *a*, head; *b*, antennæ; *c*, face; *d*, cheeks; *e*, *e*, dorsal sutures; *f*, legs; *g*, prothorax; *h*, metathorax; *i*, abdomen; *k*, dark traverse bands: *l*, line of hairs on each segment; *m*. *m*, breathing pores; *o*, female genital orifice; *p*, female claspers. Greatly enlarged. After Curtice.

No eyes are present. The thorax shows two segments, of which the former is as broad as the head, the second one broader but shorter. The elongated yellowish abdomen possesses on the first seven segments dark margins. Length 1.7mm.

This insect has not as yet been reported from Minnesota, but as the interest in sheep-husbandry is becoming greater every year it is wise to look out for this parasite, which can not be as easily destroyed as many others, on account of the longer wool of the host. Wherever it occurs it causes great annoyance to the infested animals, which try to stop the continuous irritations by as constant scratchings and bitings. Those not familiar with the true sheep-scab are very apt to mistake this one for the other. During the time of clipping the sheep close attention should be paid to these parasites. Fig. 80 shows a male of this species, fig. 81 the female, and figs. 82, 83, 84 show the egg, head and front leg of this species, as well as the anatomical details.

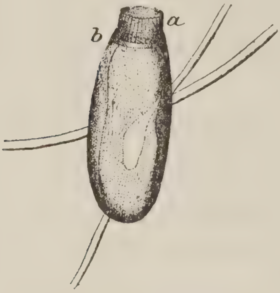


Fig. 82.—Biting-louse of sheep; egg, soon after being laid; *a*, cap; *b*, where the cap is joined to the egg. Greatly enlarged. After Curtice.

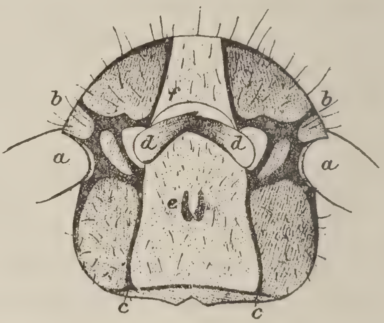


Fig. 83.—Biting-louse of sheep, showing head with mouth-parts from ventral side; *a*, *a*, antannæ; *b*, *b*, continuation of dorsal suture; *c*, *c*, ventral suture; *d*, *d*, mandibles: *e*, maxillæ showing through skin; *f*, labrum. Greatly enlarged.

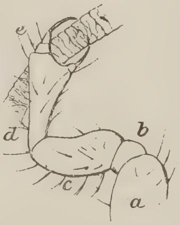


Fig. 84.—Biting-louse of sheep, anterior leg; *a*, coxa; *b*, trochanter; *c*, femur; *d*, tibia; *e*, tarsi and claws, the latter grasping a hair. Greatly enlarged. Affer Curtice.

BITING-LOUSE OF CATTLE.

(*Trichodectes scalaris* Nitzsch).

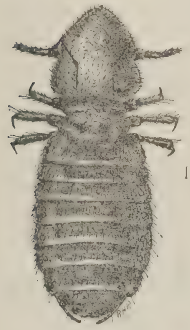


Fig. 85. — Biting-louse of cattle. Greatly enlarged. Original

This louse (fig. 85) is well-known the world over, and is sometimes so abundant upon cattle as to become really injurious, though not as much so as sucking-lice. They are distinguished by the herdsmen as "red-lice," while sucking-lice are called "blue-lice." They occur in greatest numbers during the spring of the year, when they may be found in all stages of growth, from the freshly laid egg to the adult insect. They have a heart-shaped head, as broad as long, with triangular dark spots in front of the head and feelers, which latter are located in depressions. The sides of head bear bristles. The eyes are very small. The first segment of the thorax is narrower than the second; between both, on either side, is a triangular piece, so that the segments show lateral corners. The thorax is covered with bristles; the claws are slender and but little bent, the abdomen elongated-oval; the edges of segments show corners; the dorsal surface bears bristles, and brown transverse bands mark the middle of each segment. At the sides of the last dorsal joint of abdomen is a peculiar chitinous appendage. The general color is reddish-yellow, the abdomen paler than head and thorax. Length 1.5 to 2mm.

BITING-LOUSE OF THE HORSE AND ASS.

(*Trichodectes pilosus* Giebel).

This parasite is also a very familiar insect, being found upon the horse and ass, where crowds of them are usually found upon the throat, mane, and neck. The species has not as yet been found in our state. The head of this parasite is rounded in front, and as long as broad. Marginal spots occur in front and behind the feelers; upon the middle of the head is also found a dark spot, while its posterior margin is dark brown. The thick feelers start well forward on the head, so much so that their base is nearly in line with the front border of the head. All claws are slender. The first segment of the thorax is narrow, the second broader but shorter. The cylindrical abdomen is yellow with dark bands across the segments. The whole body is covered with short hairs. General color brown. Length 1.5 to 2mm. (Fig. 86).

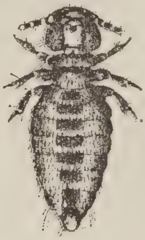


Fig. 86. — Biting-louse of the horse and ass. Greatly enlarged. After Giebel.

BITING-LOUSE OF THE HORSE.

(*Trichodectes parumpilosus* Piaget).

This is a very common parasite upon our horses, especially upon the younger ones kept in pastures. Their presence becomes decidedly manifest in stables towards spring, and the irritation caused by their presence makes the infested animals very restless, so that, in their attempts to rid themselves of their tormenters, they rub off all the hair upon infested places of their skins. The neck, base of tail, and space between the legs are particularly invaded.

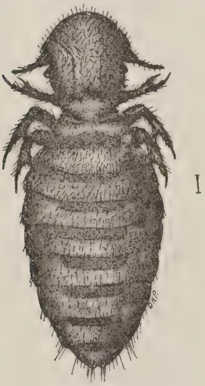


Fig. 87.—Biting-louse of the horse. Greatly enlarged. Original.

Though resembling both the *scalaris* and *pilosus* it is readily distinguished from both by good and constant characters. Its head is very decidedly rounded in front, forming a regular semi-circle; the antennæ are inserted well back; the abdomen is more slender and tapering than that of the *scalaris*, but less so than that of the *pilosus*. Head, thorax and legs are reddish-brown, the abdomen yellowish with a transverse dusky band in the middle of the anterior portion of the last eight segments. (Fig. 87).

THE BITING-LICE OF THE GOAT.

(*Trichodectes limbatus* and *climax*).

Dr. Cooper Curtice, in his excellent work on "The Animal Parasites of Sheep," describes and illustrates two species of *Trichodectes* as infesting the goat. These two species are very similiar to each other, and are, perhaps, only varieties. His illustrations are very fine, and his figures of the female of *limbatus* (fig. 88)and of the male of *climax* (fig. 89) are reproduced.

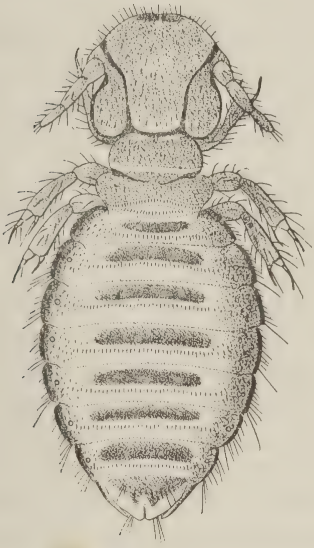


Fig. 88.—Biting-louse of the goat, female. Greatly enlarged. After Curtice.

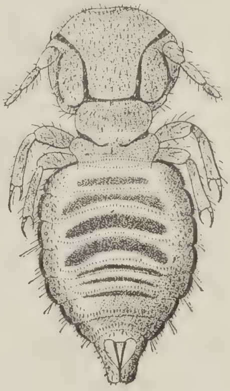


Fig. 89.—Biting-louse of the goat, male. Greatly enlarged. After Curtice

The former species, *limbatus*, is fairly common in some localities, but not here in Minnesota. It usually occurs among the coarse hair along the back and sides of the infested animals and causes much discomfort, and in extreme cases even a form of scab.

A number of other hair-lice are found upon mammals.

Some of them possess a very peculiar shape, as the one found so commonly upon pocket-gophers. But as most farmers do not care to assist these injurious animals to rid themselves of any parasites that may trouble them, no remedies have been tried in this particular case, and none are given. Perhaps it is well, however, to mention how we can kill these parasites, since by applying the remedy we can kill the host as well. Locate the gopher, close all openings to its underground home but one, and pour into this a wine-glass full of Bisulphide of Carbon, and cover up the hole with a wet sack. This chemical is very volatile, and the quickly formed fumes being heavier than the air soon fill all the underground burrows and kill every living being. This remedy, as far as the parasite is concerned, is like burning a house to get rid of the bed-bugs.

Some pets like the guinea-pig are also infested with biting lice, and remedies given for sucking-lice should be applied to kill them.

Besides mammals nearly all birds are infested with feather-lice, and some so badly as to suffer very greatly; in extreme cases these parasites even cause the death of their hosts. As a general rule each species thrives only upon one kind of host, but not always so, as some few seem to be rather general feeders. The same bird can, however, harbor at the same time a number of different kinds of feather-lice. As far as our chickens are concerned we have in the United States not less than nine different kinds that make it their business to prevent hens from sitting, either as a recreation or as a business.

All other domesticated birds are also badly infested, and to keep these parasites away or in check involves no little labor, and only very pains-taking poultry-keepers will succeed. To possess a large number of chickens is one thing, but to possess healthy and contented ones is quite a different matter. Cleanliness in every detail is just as important as the food, and even more so, as most fowls have the run of the farm and are perfectly able to forage for themselves.

As all these parasites have very similar habits, and can be fought in the same manner, only the more important ones will be given and figured, since practical people, for whom the report is written, do not greatly care whether they kill with Persian insect-powder, a *Goniocotes*, *Goniodes*, or *Menopon*, providing that the insect dies a sudden death.

The remedies we can apply against feather-lice infesting birds are not numerous, nor can they be applied as in treating hairy animals. An ounce of prevention in this case is worth more than a pound of cure. All birds, be they fowls or caged pets, useful or ornamental, should have access to a dust-pan filled with sifted coal-ashes. Whoever has watched birds enjoying a bath of this kind knows how useful it must be, and how beneficial and soothing, otherwise they would not repeat it as often as they do. If birds are infested with lice they seem to require such a dusting, which is evidently nature's remedy against all vermin of this character, and by means of which they dislodge them. The frequent use of Persian or Dalmatian insect-powder (*Pyrethrum*) is the very best remedy we possess for the purpose of killing these parasites. In buying this powder, we should make certain that it is fresh, as old powder becomes almost worthless. The active principle of Pyrethrum is an essential or etherial oil, which is volatile; if the powder is, therefore, not kept in a tight vessel nothing remains "but the dry substance, the spirit is gone." This powder, or the better one produced in California and sold under the name of Buhach, should be dusted between the feathers of the infested fowls. Their nests should also be treated in the same way.

Thorough fumigation of the hen-house with sulphur during the absence of the chickens is also an excellent rule, though the very great majority of biting-lice are away with the birds and not in the roosts. But the fumes of sulphur destroy at the same time also numerous other insects that invade the hen-houses, as well as vegetable parasites. For this very reason the inside of the hen-house should be whitewashed from time to time, and a thorough spraying with kerosene should not be omitted. Sand-baths, in which the sand is slightly moistened with kerosene oil, has also many advantages. If hen-houses were built in such a manner that sunlight could reach every nook and corner, all sorts of parasites would become scarce.

FEATHER-LICE INFESTING CHICKENS.

(*Goniocotes hologaster* Nitzsch).

This very common and troublesome parasite, the female of which is shown in fig. 90 and the male in fig. 91, is only about 1mm. in length. It has a nearly square head; its abdomen is not very conspicuously marked, and the incurved margins of the segments do not extend very much upon the dorsal surface, as is the case in many other species, and which produce the very distinct lines and borders seen there.

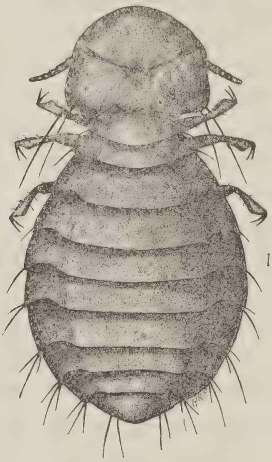


Fig. 90.—Biting-louse of the chicken, female. Greatly enlarged. Original.

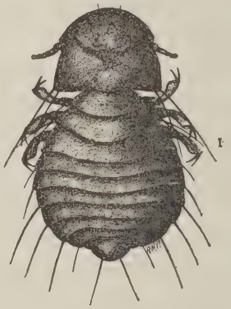


Fig. 91.—Biting-louse of the chicken, male. Greatly enlarged. Original.

Goniocotes abdominalis Piaget.

This very conspicuous parasite is also fairly common and decidedly troublesome. It is much larger, measuring about 3mm. in length. The head is almost circular in front, constricted behind; the thorax is small. Head, thorax and legs are yellowish, marked with dark margins and spots. The segments of the abdomen are marked with white fasciæ with black borders, as shown in the illustration, fig. 92.

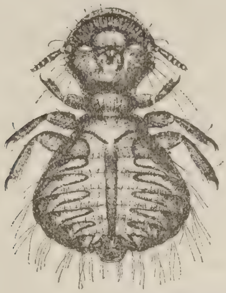


Fig. 92.—Biting-louse of the chicken. Greatly enlarged. After Nitzsch.

Goniocotes burnettii Pack.

Dr. Packard describes this feather-louse as occurring in large numbers on the domestic fowl. The illustration (fig. 93) shows its general appearance. It is a slightly yellowish insect streaked with black markings.

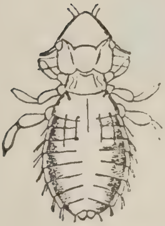


Fig. 93.—Biting-louse of the chicken. Greatly enlarged. After Packard.

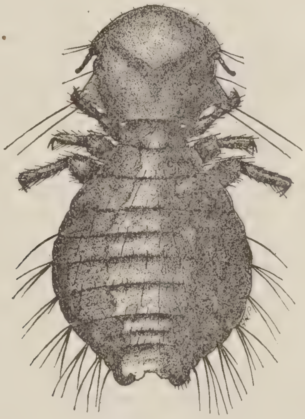


Fig. 94.—Biting-louse of the chicken. Greatly enlarged. Original.

Goniodes dissimilis Nitzsch.

This large species seems to be rather common upon our chickens; it measures from 2 to 2½mm. in length, and is of a tawny color. It is rather smooth and shining. The parasite has a large subquadrate head, a short transverse thorax and a large abdomen, with confluent markings on the sides. The illustration (fig. 94) shows a female.

Lipeurus heterographus Nitzsch.

This parasite has been described as occurring quite commonly in Europe upon the domestic fowl and upon pheasants, and is very likely to be found here as well. It is illustrated in fig. 95.

Lipeeurus variabilis Nitzsch.

The illustration (fig. 96) shows this peculiar insect, which is quite common in Minnesota. It measures about 2mm. in length, and possesses a very elongated, smooth and shining body of a whitish color. The black margins of the body, and the markings of the dorsal surface, distinguish it from all other feather-lice infesting chickens.

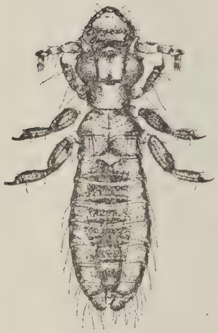


Fig. 95.—Biting-louse of the chicken. Greatly enlarged. After Piaget.

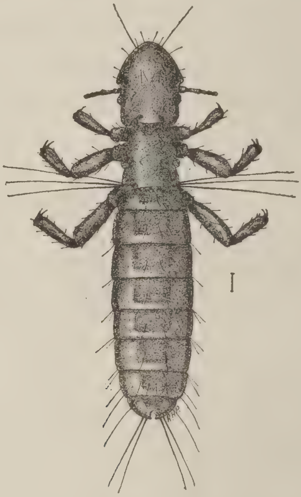


Fig. 96.—Biting-louse of the chicken. Greatly enlarged. Original.

Menopon pallidum Nitzsch.

This is the common hen-louse, so familiar to all interested in poultry raising, and so injurious to the chickens, and chiefly so to the younger ones. There is scarcely a chicken, which, if closely inspected, will not reveal its presence. This parasite is very active, and moves about the feathers of the infested fowls with great celerity. But it also leaves its host quite readily, and passes upon the heads and bodies of persons holding the same, where it is quite annoying, though, of course, for only a short time, as it either soon leaves or dies. Horses in the vicinity of hen-houses, in which are kept infested chickens, soon suffer from the presence of such lice.

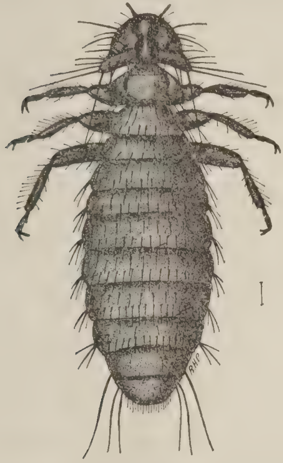


Fig. 97.— Biting-louse of the chicken. Greatly enlarged. Original.

The louse is of a yellowish color, slender, and measures from 1 to 1½mm. in length. As the illustration (fig. 97) shows, it is quite distinct in shape from the other feather-lice infesting the same animal.

Hen-houses once infested have to be thoroughly cleaned, and the remedies given elsewhere must be most thoroughly applied to secure good results.

As all insects breathe by means of spiracles located in their sides, any kind of oil spread over an insect will kill it by suffocation, because the spiracles become closed. If a little fat or grease is put under the wings of a hen, close to the body, most lice will be killed; the same result will be reached if a small bit of fat is put upon the head of a young chicken just hatched. But care must be taken not to apply too much fat, as the remedy would be worse than the evil, by coating the skin of the young chicken, which would result in its speedy death. Pyrethrum is in such a case the only safe remedy.

FEATHER-LICE OF DUCKS, GEESE, AND SWANS.

(*Docophorus icterodes* Nitzsch).

Species of parasites belonging to this genus possess in front of their feelers a small and moveable tooth-like projection, and are thus easily separated from other feather-lice.

They occur upon many species of aquatic birds like ducks and geese. This species is about 1mm. long. The head and thorax are of a bright red color with dark bands; the abdomen is whitish in the center, and has broad and horny bands of a dark reddish color at the sides, which possess a still darker spot at the margin (fig. 98).

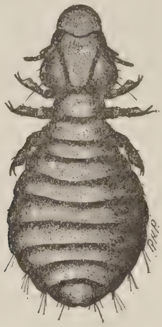


Fig. 98. — Biting-louse of ducks, etc. Greatly enlarged. Original.

Docophorus cygni Denny.

This small parasite, only 1mm. long, and of a robust form, is found upon the swan. Its roundish head, the narrow thorax, and the legs are bright reddish-brown; the abdomen is white in the center, while the harder plates on the sides are brown.

Lipeurus tadornæ Denny.

According to Prof. Comstock this feather-louse is found upon the goose; others have been found upon the sheldrake. This parasite is white, with a smooth and shining surface and of an elongated form; its heart-shaped head, the thorax, and the abdomen possess black spots along the margins.

Lipeurus squalidus Nitzsch.

Most species of wild ducks, as well as the domesticated ones, are infested with this parasite. It is a large insect measuring about 4mm. in length. Its elongate form is of a light-yellowish color with a darker border of the thorax and

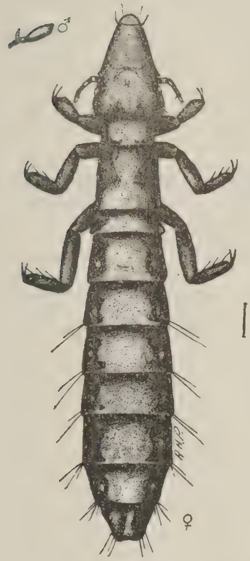


Fig. 99.—Biting-louse of ducks, etc. Greatly enlarged. Original.

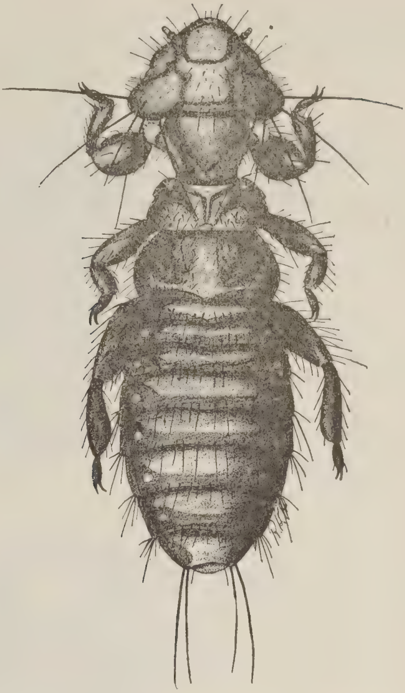


Fig. 100.—Biting-louse of ducks, etc. Greatly enlarged. Original.

abdomen, which in the latter, is broken up into little squarish patches. (Fig. 99.)

Lipeurus anseris Gurlt.

This species is also stated to occur upon the domesticated goose.

Lipeurus jejunus Nitzsch.

This slender pale yellowish-white parasite, with a black margin and four-sided bands upon the first eight segments, and with dark legs, is also found upon our domestic and wild goose.

Ornithobius cygni Denny.

This handsome feather-louse occurs in large numbers upon wild and domestic swans. It is a large species, measuring about 4mm. in length, with a slender and flattened body.

Its color is white and very transparent; it is ornamented with a number of black spots.

Trinotum luridum Nitzsch.

Most of our ducks are more or less badly infested with this large feather-louse, which measures 4 to 5mm. in length. It is a well-marked species, as can be seen in the illustration (fig. 100).

Trinotum conspurcatum Nitzsch.

This species is said to be found upon the goose and swan.

Trinotum lituratum Nitzsch.

This peculiar animal is not uncommon upon the domestic goose, but has also been repeatedly taken from Green Teals. It is white and almost transparent. The illustra-

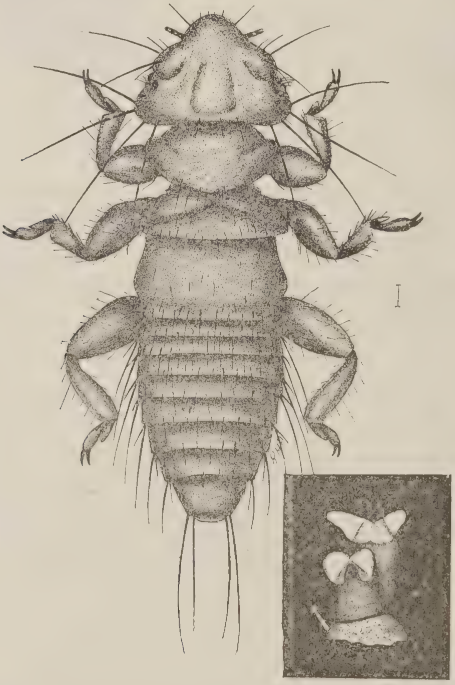


Fig. 101.—Biting-louse of ducks, etc., and tarsus. Greatly enlarged. Original.

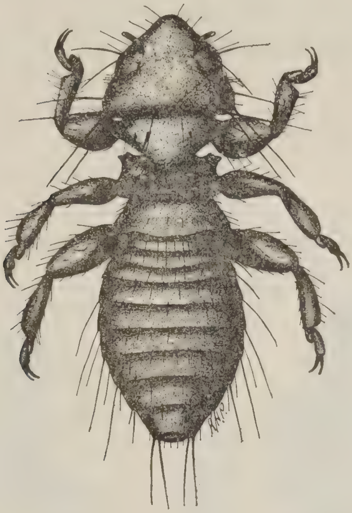


Fig. 102.—Biting-louse of ducks, etc. Greatly enlarged. Original.

tion, (fig. 101) which is too dark, shows this peculiar parasite.

Still another species of *Trinotum* is found on duck; it is illustrated in fig. 102.

FEATHER-LICE INFESTING THE PIGEON.

It seems that pigeons are very prone to being infested by parasites. There is no doubt that many species of feather-lice occur upon them, and it is not infrequently stated that they can carry bed-bugs from house to house, in fact that they are to blame for the very existence of these nocturnal blood-suckers, which, without pigeons, would not have invaded our dwellings. All such statements do not amount to much, however, as they can not be substantiated by facts. But there is no doubt about feather-lice infesting pigeons, as will be seen by the following descriptions of species found upon them.

Goniocotes compar Nitzsch.

This parasite is quite common upon domesticated pigeons. It possesses a head well-rounded in front, narrow between the feelers, and broadest near the posterior margin. The thorax is narrow, the abdomen, in the male (fig. 103) broadest near the posterior end, in the female (fig. 104), more regular and broadest in the middle. The insect is whitish, with a brownish margin. It measures a little more than 1mm. in length.

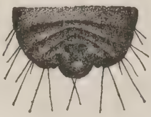


Fig. 103.—Biting-louse of pigeon, male, posterior end. Greatly enlarged. Original.

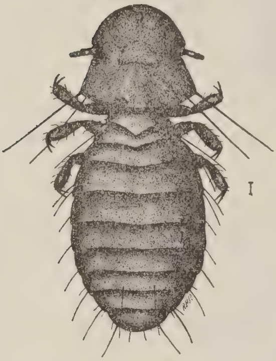


Fig. 104.—Biting-louse of pigeon, female. Greatly enlarged. Original.

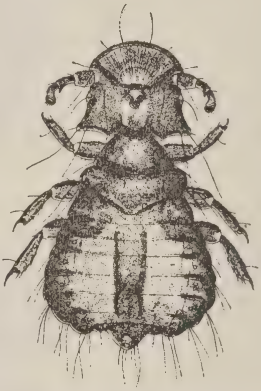


Fig. 105.—Biting-louse of pigeon. Greatly enlarged. After Nitzsch.

Goniodes damicornis Nitzsch.

This species, about 2mm. long, and of a brownish color, has a head well rounded in front and strongly angular behind. It appears to be common upon pigeons. Fig. 105 shows a male of this parasite.

Goniodes minor Piaget.

This species is also found upon the domestic pigeon.

Lipuerus baculus Nitzsch.

Almost every pigeon is infested with this peculiar insect. Its shape is very striking, and quite different from that of almost any other feather-louse, being extremely slender, almost hair-like. The head and thorax of this parasite, illustrated in fig. 106, is bright reddish-brown; the abdomen

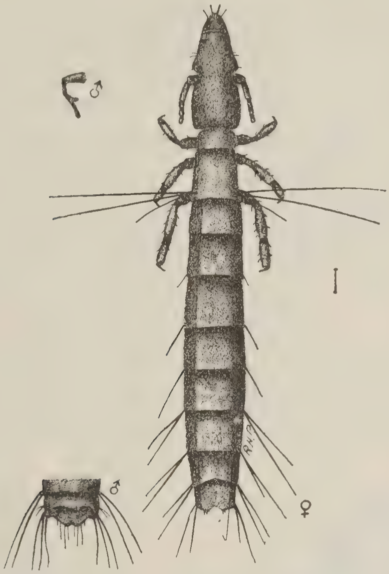


Fig. 106.—Biting-louse of pigeon. Greatly enlarged. Original.

is dusky with a series of bright brown patches. It measures about 2mm. in length.

Colpocephalum longicaudum Nitzsch.

This feather-louse is also described as a parasite of the pigeon, but seems to be uncommon, at least in the United States.

FEATHER-LICE OF PEACOCK, GUINEA-FOWL AND TURKEY.

Goniocotes rectangulatus Nitzsch.

This is a small parasite with a squarish head rounded in front, and with a short and oval abdomen. It is a quite common inhabitant of the feathers of the peacock.

Goniodes falcicornis Nitzsch.

This parasite of the peacock is quite large, measuring from 3 to 4mm. in length; it is of a bright reddish-yellow color. The abdomen, quite broad, is yellow, with very prominent transverse bands extending almost to the dorsal line. The large head possesses acute and prominent hind angles; the feelers in the male are large and bear a prominent tooth.

Goniodes numidianus Denny.

A number of these and of a very similar parasite were taken some years ago from the guinea-fowl, but the specimens could not be found to use for an illustration.

Goniodes stylifer Nitzsch.

This insect has been described a long time ago as being common with three other species upon the domestic and wild turkey, where it infests chiefly the head and neck. It can be distinguished from others by the peculiar hind angles of the head, which are extended backwards into long styles armed with stout bristles. The very narrow first segment of the thorax, and the broader second one, are marked with a dark margin; the abdomen is pale with dark transverse bands. The species measures about 3mm. in length. (Fig. 107.)

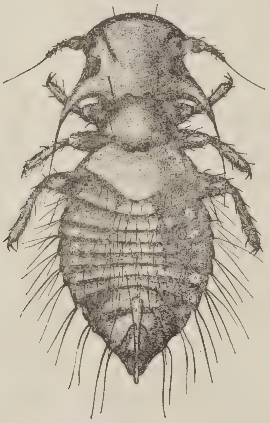


Fig. 107—Biting-louse of turkey. Greatly enlarged. Original.

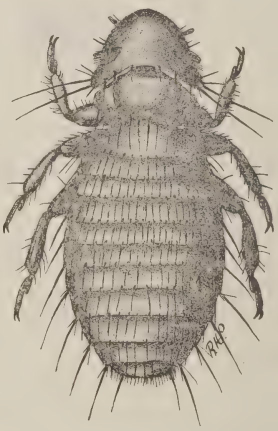


Fig. 108.—Biting-louse of peacock. Greatly enlarged. Original.

Lipeurus numidæ Denny.

This livid-yellow louse is said to occur on the guinea-fowl.

Lipeurus polytrapezius Nitzsch.

The peculiar species is common wherever turkeys are kept, and is easily detected, being large enough to be readily seen, measuring from 3.0 to 3.5mm. in length. It has a very elongated, flat, and pointed body, which is pale-yellowish, with a dark margin. All the segments of the abdomen, with the exception of the last, have a grayish-brown trapezoidal spot on each side, whence the scientific name. This very active insect prefers the wing-feathers.

Menopon phæstomum Nitzsch.

This parasite infests the peacock, and seems to be very common. It is illustrated in fig. 108.

Menopon numidæ G.

This insect is found on guinea-fowls.

H. FLEAS.

(*Siphonaptera Pulicidæ*).

These insects possess a laterally compressed body; the thoracic segments are well separated; wings are missing but represented by two pairs of short and stiff scales, that have no or very little power of motion; feelers are very short, composed of three flat and singularly lobed joints, which are in most species closely folded away in a cavity behind the eyes, while in some others they are exposed and erect. The peculiar sucking mouth (fig. 109) is well adapted for piercing the skin. The mandibles and labium form three slender lancets; the blood is drawn up through the channels or spaces between them and the labial palpi and lower lip, by means of a sucking stomach. The large posterior legs are very powerful, enabling the fleas to leap with remarkable agility enormous distances compared to their size. The head is small; the eyes are simple, and in some cases very minute. The white and worm-like larvæ are long and cylindrical, composed of head and thirteen segments, which are provided with long hairs; the pupa is inactive.

Fleas, which are degraded flies—degraded by leading a parasitic life—are not as common in the United States as in other countries; at least the species attacking man is not universally found. Other species, however, are sometimes extremely troublesome, chiefly in warm regions with a sandy soil; here few persons are found that do not know from personal experience these active parasites. Portions of the Mississippi Valley, Southern California, and Florida are not favorably celebrated on their account, and chasing the festive flea in these states is said to be a sport not limited by any game law.

THE HUMAN-FLEA.

(*Pulex irritans* Linn.).

This parasite, perhaps better known than any other one, is a very common insect in the old world, being found almost everywhere, and consequently an intruder and tormenter that is not readily excluded from houses, no matter how careful and cleanly the inhabitants may be. Here in the United States it is not common. In fact most of the complaints made about fleas do not apply to this insect at all, but to fleas that infest dogs, cats, and other animals found in houses. They will attack man, however, without the slightest hesitation, though they do not feel at ease upon this new host, being used to move among dense hair; and on this account they are always restless upon man, move about constantly and so cause great irritation.

The old statement: "who sleeps with dogs rises with fleas" is wrong, however, as the dog flea is nowhere so happy as upon the dog. The female deposits in the course of her existence, about 800 eggs, which are large, pearl-gray and elongated-oval; from 12 to 20 eggs are laid in the cracks on the floor, in dark corners, or wherever dead organic matter accumulates. As a general rule the female surrounds the egg with some blood, which, though dry long before the young larval flea hatches, forms part of its food; dead flies, which are found in such localities, are also eaten.

The eggs hatch in about six days, at least during the warmer part of the year. The white larvæ are furnished with feelers and eyes, a very unusual thing in insects. Though without feet they move about very rapidly in a serpentine fashion; they soon turn yellowish, and later they gradually become brownish. In about eleven days they are fully grown. They now form a sort of loose cocoon, composed of particles of dust, inside of which they transform into a pupa, which is at first of a white, but later of a brown color. After ten to twelve days more the adult flea (fig. 110) appears, ready to torment its host, man. In warmer countries the flea passes all these metamorphoses in much shorter

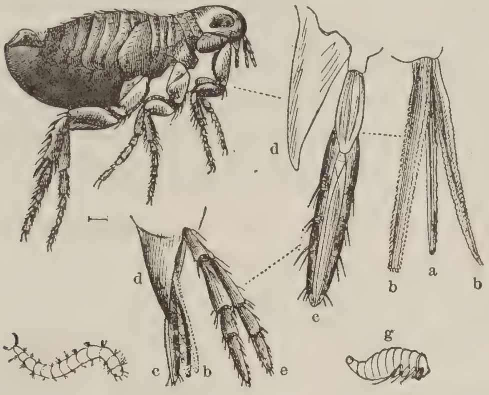


Fig. 109.—Mouth-parts of human-flea. After Taschenberg

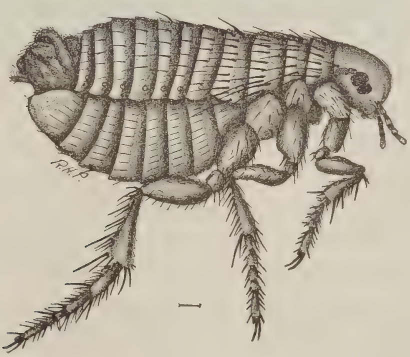


Fig. 110.—Human-flea. Greatly enlarged. Original.

time. Born, perhaps, in a filthy hut, the flea, depending upon the great strength of its armor and its power of rapid motion, boldly attacks even princes born in castles. The flea is decidedly a republican, who cares for neither titles nor positions! To realize how great tormenters fleas can become it is only necessary to enter a house tenanted by them, and which has not been occupied by man for some time. To get rid of them sticky fly-paper fastened to the legs is an excellent remedy, and immense numbers of fleas are caught while the person thus equipped walks over the floors of infested rooms.

In some parts of the old world fleas are exceedingly abundant, and it seems that the more that are killed the more come to attend the funeral, and their activity, their energy and their appetites are prodigious. In Tom Moore's words—

> "You may crush, you may smother, the flea as you will,
> But his brothers and sisters will cling round you still!"

We have in our own country also many localities where a "flea hunt" is a regular occupation of many a mother as she tucks up the little ones before retiring to rest.

The length of the reddish-brown or pitchy-brown male varies from 2 to 2.5mm.; of the female from 3 to 4mm.; the larva measures 3.5mm., and the egg 0.7 to 0.8mm.

It is frequently stated that fleas multiply very rapidly in saw-dust impregnated with liquid manure, and saw-pits near mills are said to breed even millions of them. In fact many people claim that they are here produced in spite of all natural laws, i. e. by spontaneous generation. Of course the latter is all nonsense, though the fact remains that such places, being just suitable for the growing larvæ of fleas, attract the adult ones. Strange to say many fleas obtained from saw-pits in Minnesota were all specimens of the human-flea.

It is well-known that fleas have been trained to perform in a kind of minute circus. Of course such fleas are not really trained; they are simply forced to act in a certain manner and the whole performance is a case of cruelty that should not be permitted. The strength of fleas is best given by stating that a single flea has been known to draw, with ease, a silver cannon weighing 70 times its own weight.

Good and thorough ventilation of the rooms, cleanliness, and the free and repeated use of insect-powder will drive fleas from houses infested by them.

The flea infesting man differs greatly from those infesting animals; it has no spines on the head or on the back of the thorax, while the posterior margins of the segments of the thorax and abdomen possess rows of stiff hairs pointing backwards. The peculiar comb-like bristles upon the head and the posterior part of the thorax found upon the dog-flea and others are absent.

THE DOG AND CAT-FLEA.

(*Pulex serraticeps* Gerv.).

This is the well-known flea infesting cats and dogs. Wherever pets are kept that harbor the above parasites these latter are certain to cause much trouble, as they seem to prefer carpets and similar places, in which they conceal themselves during the day. In this way they will reach the bodies of persons walking over them, and tender-skinned children and ladies are frequently poisoned by their bites. Fleas are not like mosquitoes or other blood-sucking insects, which bite but once if not disturbed; they bite as they move about, literally "bite on the run."

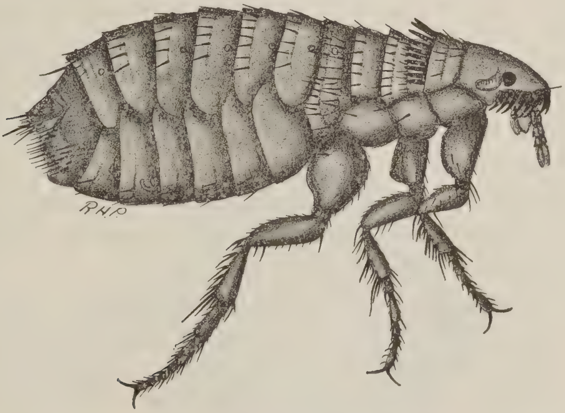


Fig. 111.—Dog and cat-flea. Greatly enlarged. Original.

These dark chestnut-brown fleas (fig. 111) are stouter and thicker in the thoracic region than those infesting man, which are darker and have a more slender waist. A row of sharp spines is found on the lower margin of the head, and another one on the posterior edge of the first segment of the thorax; both sets of spines are absent in the human flea.

The female flea deposits her eggs among the fur; as these very small, white, elongated eggs (fig. 112,*a*) are but slightly attached to the hair they drop off quite readily and are thus scattered; they can be easily found wherever infested cats or dogs sleep. The young larvæ hatch in a few days, according to the season; they have a pale yellow head and are furnished, like the larvæ of other fleas, with two spines on the last segment of the body, and with very long hair along the sides. The footless larvæ (fig. 112, *b*) move by means of these spines and hairs. The pupa, which resembles more the adult stage than the larval one, has free legs. As soon as the adult flea is born, it attacks the first living animal to obtain blood. As the larvæ can exist upon all sorts of dead organic matter they even hatch from eggs dropped by dogs or cats in gardens, and these can reach maturity in such places. Such fleas are called "sand-fleas", but they are simply the offspring of cat or dog-fleas.

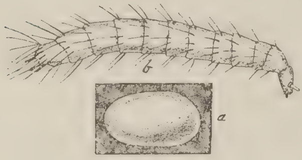


Fig. 112.—Dog and cat-flea; *a* egg; *b*, larva. Greatly enlarged. Original.

Fleas pass the winter in all stages; in fact they are always active and the females seem to drop eggs quite frequently, even during the coldest season, hence many must perish. During the late cold spell (Nov. 1896) the female fleas taken from a rabbit dropped their eggs quite readily, but as it is not likely that they would do so if these would or could not hatch, the eggs, perhaps, do not develop until spring. As fleas increase so rapidly in numbers there may be a number of broods during a year.

The dog-flea was at one time considered to be different from the cat-flea, but it is so very similar, and the differences in the mouth-parts and proportions of the posterior tarsi are so slight, both have been united into one species. The habits of both are identical. Human blood is to the taste of both, but is not preferred as being better and richer than that of the normal hosts.

REMEDIES.—Fresh insect-powder, dusted or blown among the hairs of the infested animals, is an excellent remedy; it should also be dusted upon the places where they sleep. As the insect-powder usually bought is very much adulterated or too old, it would be best if we grew in our gardens the plant from which it is made. This is *Pyrethrum roseum*, a rather pretty plant, which makes also a nice border for flower-beds. The flower-heads should be cut off when fully expanded, and have to be dried in the shade. When needed these dry heads should be ground as fine as possible, and excellent results will follow wherever such powder is used in a legitimate way, *i. e.* against such insects as can be killed by it.

THE SAND-FLEA.

(*Sarcopsylla penetrans* L.).

This is a flea that is not found in Minnesota, being an inhabitant of Central and South America, where it abounds in and about indian lodges, wood-cutters' camps, and similar places free from the rank vegetation found in those countries. This parasite is known by a number of names, such as Jigger, Chigoe, Chique, Biche, or Pique. As it has a somewhat different form from those mentioned before it has been taken

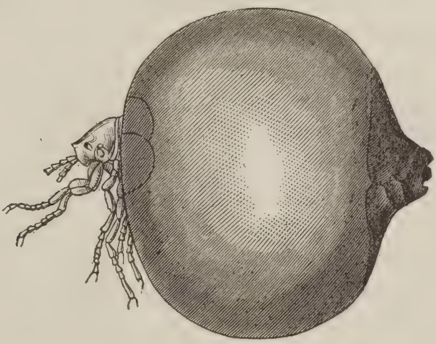


Fig. 113.—Sand-flea, female with eggs. Greatly enlarged. After Karsten.

from the old genus *Pulex* and placed in another one. Both sexes imbibe blood of man and many other animals, as dogs, hogs, cats, goats, sheep, cattle and rodents, just like other fleas; but as soon as the female is ready to deposit her eggs she penetrates so deep into the skin of man or animal that only the posterior end is visible. In man she selects the space beneath the nails, chiefly of the toes, and here her abdomen swells to the size of a pea (fig. 113). The eggs are deposited from time to time, and forced out of the invaded place drop to the ground, where they hatch and live like the eggs and larvæ of other fleas. The male is shown in fig. 114.

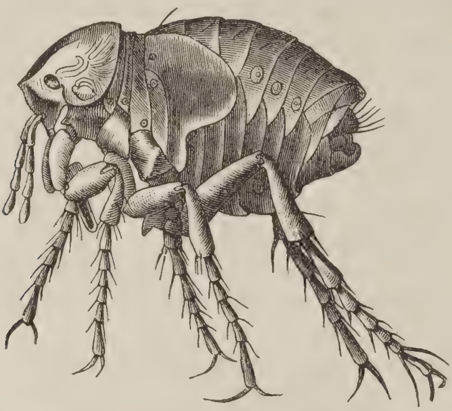


Fig. 114.—Sand-flea, male. Greatly enlarged After Karsten

Sand-fleas have been carried from America to Africa, and with greater intercourse between the United States and tropical America it is possible that they may also become much more numerous in our more southern states.

The injuries caused by the female of Chigoe to the human host are not great if the proper pains are taken to remove the swollen insect from beneath the toes without rupturing her skin. Yet all sores caused by insects in the tropics are much more dangerous than elsewhere, and in many cases the loss of a toe, even of a life, has been the consequence of carelessness. If the female is left under the toe no serious consequences take place, as the larval fleas do not live there, as is frequently stated.

Length of sand-flea 1 to 1.2mm.; of females swollen with eggs 5 to 7mm.

A simple remedy, or rather preventive, is rubbing the feet with Peruvian-balsam or Kopai-balsam.

THE HEN-FLEA.

(*Sarcopsylla gallinacea* Westwood).

This flea (fig. 115) was but once found in a chicken-house in Minnesota. It is common in Florida and Texas, where it is known as the "Jigger-flea." It is a peculiar, roundish looking flea, quite smooth, and of a yellowish-brown color. As it is assuredly not a common insect with us no detailed description is given, as the illustration shows its peculiar shape quite well.

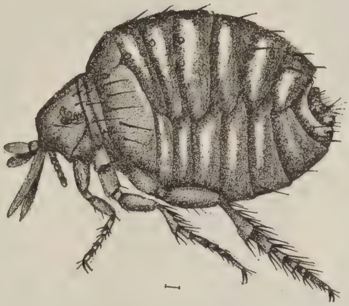


Fig. 115.—Hen-flea. Greatly enlarged. Original.

The Pigeon-Flea (*Pulex avium* Tasch.) is also found in the United States, but the writer has not been able to obtain specimens thus far in our own state, and it is very doubtful whether it exists here.

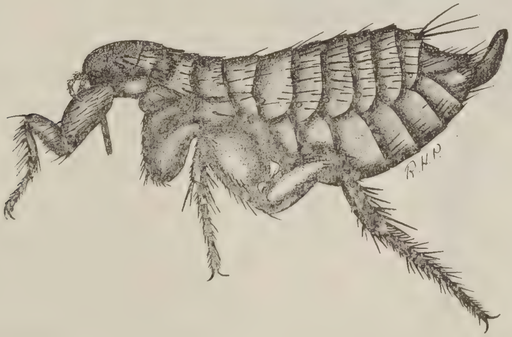


Fig. 116.—Flea of the mouse. Greatly enlarged. Original.

A number of other species of fleas are found in Minnesota, which infest rats, mice, bats, rabbits, pocket-gophers and various other wild animals. The following four species have been found in dwelling places, no doubt brought there by the hosts they infest. No description is given of them, as the illustrations are sufficient to show their peculiarities.

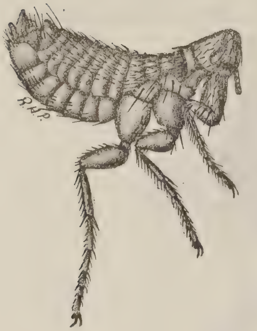


Fig. 117.—Flea of shrew. Greatly enlarged. Original.

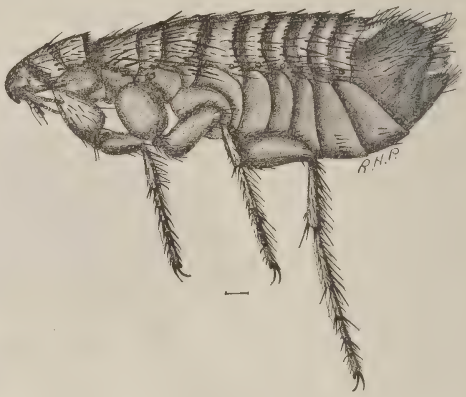


Fig. 118.—Flea of bat. Greatly enlarged. Original.

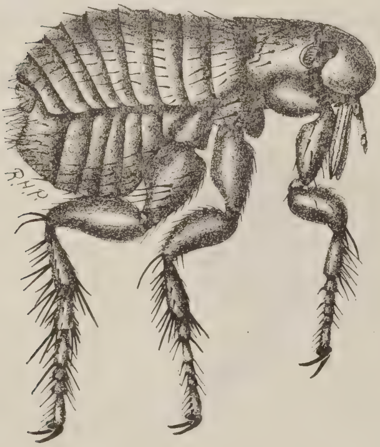


Fig. 119.—Flea of rabbit. Greatly enlarged. Original.

The Flea of the Mouse is shown in fig. 116, the one infesting the *Shrew* is illustrated in fig. 117, and the one found upon the *Bat* in fig. 118. Even if found in houses they are only accidental visitors, and as they can not exist upon man and domesticated animals they will soon disappear. The flea infesting the *Wild Rabbits*, sometimes in very large numbers, is also occasionally found in the kitchens where this game is made ready for dinner. This species is shown in fig. 119.

I. LOUSE-FLIES.

(*Hippoboscidæ*, *Pupipara*).

Louse-flies are very peculiar insects, belonging to the order of flies (*Diptera*); both their form and mode of reproduction are very abnormal. They are parasitic, living upon the bodies of mammals and birds. Closely allied insects, with similar life-histories, are found upon bats and the honey-bee. Some louse-flies are winged, others are not, but in the latter case we find on each side of the thorax, near the anterior angle, a small round spot; indicating where the upper-wing should be, and near the posterior angle a small projection which seems to represent the balancers, or remnants of hind wings. All louse-flies possess a depressed body and widely separated, short, and stout legs, furnished with strong claws, which in some cases have teeth. The last joint of each foot bears a feather-like organ, probably used to coil around the hair for a stronger foothold, (see enlarged foot in fig. 120). The head, nearly as wide or wider than the thorax, is sunk in the same without a distinct neck; the feelers are very short, apparently one-jointed, with a termi-

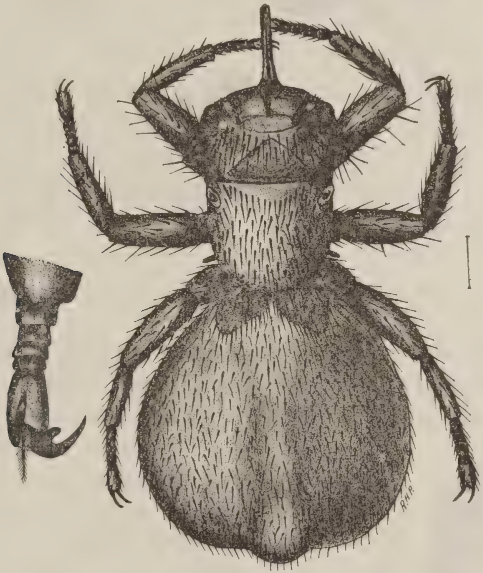


Fig. 120.—Sheep-tick and enlarged foot. Greatly enlarged. Original.

nal bristle, and situated in a depression near the mouth. This is a tubular proboscis, protected on the outside by two flat and elongated bristly pieces, the labrum. The organs used in piercing the skin and in drawing blood are three long and slender bristles of equal length but unequal size, which are withdrawn when not in use. A glance at the illustration of a head of the sheep-tick, (fig. 121), will explain this peculiar structure better than words. The abdomen is flat and bag-like. The whole insect is densely clothed with hair and bristles; the sexes resemble each other, the male being simply smaller.

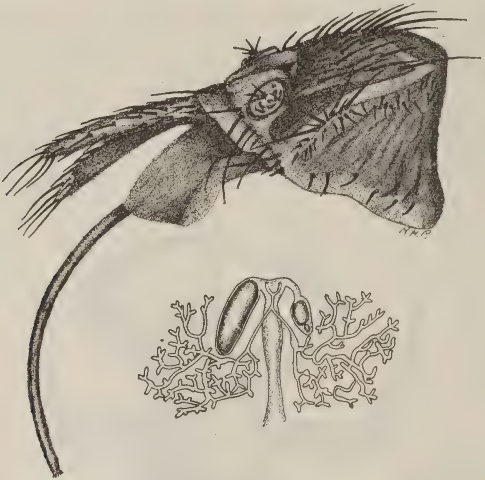


Fig. 121.—Head of sheep-tick. Original. Below uterus-like enlargement of oviduct. Greatly enlarged. After Leuckart.

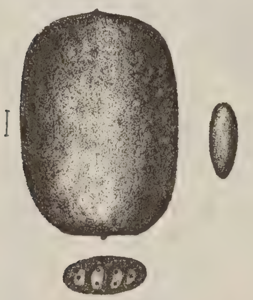


Fig. 122.—Young larva and puparium, with breathing-pores, of sheep-tick. Greatly enlarged. Original.

The life-histories of these parasites are very abnormal, as they bring forth full-grown larvæ, which soon change to pupæ without first taking food outside of the mother. The insect, instead of depositing an egg upon suitable food, as nearly all other insects are in the habit of doing, retains the same inside an uterus-like enlargement of the oviduct, (shown below head in fig. 121), where it is hatched. Here it is nourished by a milky secretion produced in special glands, also shown in illustration, until the larva has attained its full size, when it is born. Such a larva is white, but it soon turns brown and becomes a puparium, as shown in fig. 122. To prevent this puparium from dropping from the host it is fastened to it by means of a sticky material. Here it remains for sometime, when the mature insect emerges by forcing off a round lid from one end of the dry and glassy puparium. The illustration (fig. 122) shows such a puparium; the upper and pointed end was connected with a membrane through which the larva obtained food; below are seen the spiracles, and to the right a young larva removed from the mother fly.

All louse-flies seldom remain attached to the skin longer than to fill themselves with blood. They are active and try to escape by running in a peculiar sideways fashion among hairs and feathers. They can move forward with equal ease, and act somewhat like a crab. Those equipped with wings fly away when disturbed, and leave their host, as do those found upon birds of prey as soon as the body of the dead bird becomes stiff and cold.

Only two species of louse-flies infest our domesticated animals, and the best known of all the external parasites of the sheep, the so-called "sheep-tick," is one of them.

THE SHEEP-TICK.

(*Melophagus ovinus* Linn).

It is not a true tick, which possesses eight legs, as illustrated elsewhere, but a true six-legged insect. It is less than a quarter of an inch long (4.4mm.), with a short, flattened, tough and leathery body covered with hairs. The illustration (fig. 120) shows this insect, and some of its structural details.

It is a veritable pest, especially in spring, to the younger animals it infests. Sheep always kept in stables are almost free from such parasites, which seem to require conditions only found upon pastures. When we consider that a female of this parasite only produces one offspring at a time, and perhaps only four to five during her whole existence, it is difficult to explain the very large numbers of ticks sometimes found upon a single sheep.

Dr. Curtice who studied the parasites of the sheep most thoroughly, writes: "to feed them they were placed upon the back of my hand. By this means I could, with a lens, watch them bore into the skin and see the abdomen slowly enlarge as they drew in the blood. They had some difficulty in penetrating the thick skin, but usually succeeded by slipping their tube into a hair follicle. At first no itching or irritation was felt, except a slight twinge when the bills first penetrated the skin; but little swellings came on a day or two later which itched for over a week. The itching was far more persistent than with mosquito bites. They must in this way cause lambs much discomfort. It was at first thought that a fluid could be seen running from the parasite to the hand through the bill, but no more was thought of it until the elevations began to rise and itch; then it appeared that the little pests had secreted a poisonous fluid. The office of this secreted fluid is probably to assist the flow of blood by keeping it from clotting." It is more likely, however, that such poison is injected to draw the blood to the spot inflamed by it.

Remedies.—The presence of such parasites must cause considerable itching, and particularly so to lambs with a tender skin, and if very numerous they can cause serious trouble. As they multiply but very slowly there is no reason why they should ever become so numerous as is really the case, even in so-called well-kept herds. If not numerous, tobacco or other mixtures used for sheep-dips will rid the animals of these intruders. Such remedies should be used at shearing time, when all parasites not removed with the wool can be readily reached. Fall dipping is advised by many. For this purpose, as well as for dipping at any other time, a kerosene-emulsion is recommended. This is made in the following manner: "Churn fresh skimmed milk and kerosene together in the proportion of one gallon of milk to two gallons of kerosene, either in a churn or by using a force-pump, until an emulsion is made. The method of using a force-pump is to set it in a vessel containing the mixture and to force the stream back into the same vessel. The emulsion will form quicker if boiling hot milk is used. For dipping use, one gallon of the emulsion for each ten gallons ofwater is required. Fifty gallons of this dip will suffice for fifty sheep, seventy will probably answer for one hundred. Much depends upon the amount of waste on account of the liquor being carried off by the fleece."

Another very effective remedy, much used in Europe, from where this parasite reached the United States, is the following one, which seems to be very simple. A small piece of gray mercurial salve, about the size of a hazelnut, is well rubbed upon each animal along the back, below the throat, and between the front legs, immediately after shearing. This application should be repeated after ten days to destroy any new intruders.

THE HORSE-TICK OR FOREST-FLY.

(*Hippobosca equina* Linn.).

These parasites are winged, and attack, during summer and early autumn, horses, cattle, and even dogs. They infest those parts of the animals which have the thinnest skin and fewest hairs, as regions about the tail and the belly.

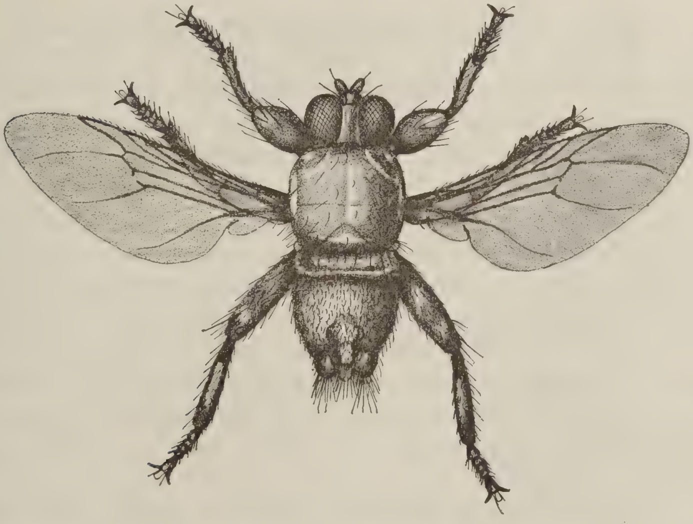


Fig. 123.—Horse-tick. Greatly enlarged. Original.

Here they insert their beaks to draw blood. It seems that they irritate the infested animals more by their running over them than by the absorption of blood, though they must also cause pain. Horses attacked by such tormenters become very restless, even dangerous and unmanageable. As the insects are very active they are not very easily captured, for they either fly away or cling so firmly to the skin that they can not be removed without difficulty, nor can they be crushed, as they are well protected by a very smooth and exceedingly tough skin. If these parasites escape, after having been captured, they are apt to return instantly to the horse; but as mistakes are not impossible they have been known to invade the heads of men, where they are, for a short time, very unpleasant and unwelcome guests.

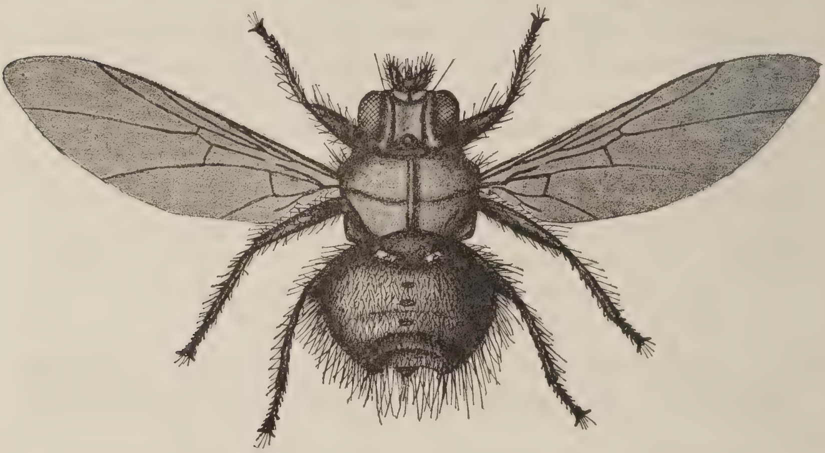


Fig. 124.—Louse-fly from Grossbeak. Greatly enlarged. Original.

This fly measures from 6.6 to 8.8mm. The thorax is very dark-brown with conspicuous yellowish markings; the legs are yellowish with brown rings; the abdomen is grayish-brown. The illustration (fig. 123) shows the structure of this peculiar parasite; it was made from a rather poor specimen.

The whitish larva, when leaving the mother, is already enclosed in a very thin shell, which turns brown in about four hours, and bright black in twenty. The adult fly leaves this puparium in about four weeks.

The same remedies as those mentioned against the sheep-tick should be applied in this case.

Some birds, such as hawks and owls, almost always harbor a number of such winged parasites among their feathers, and taxidermists are often tormented by them when skinning such birds. But other birds do not escape, for instance the louse-fly illustrated in fig. 124 was found upon a pet Grossbeak.

J. OTHER FLIES.

(*Diptera*).

A very large number of insects belonging to the order of Diptera or Flies, which includes insects that possess but two wings instead of four, are more or less troublesome to man and domesticated animals. Some simply irritate them by running over their bodies; others live upon the moisture (sweat, etc.), that is found upon the skins of their hosts; still others suck their blood, and some enter them bodily, causing sores and even death.

THE COMMON HOUSE-FLY.

(*Musca domestica* Linn.).

Perhaps this is the best known of all insects, and few persons are not familiar with their actions. House-flies are, however, more familiar with us than we are with them, judging from the general ignorance in regard to their life-history. As most persons know so very little about this common insect, the following article of the writer is reprinted from the Annual Report of the Minnesota State Horticultural Society for 1895:

"Your active secretary gave me a rather peculiar text for a paper. I do not quite understand why he should have selected such a theme, as he assuredly knows that 'there are no flies on' Minnesota horticulturists." Or did he, perhaps, mean that they are constantly on the fly, meeting here and there in our beautiful state? But whatever were his reasons, I will try to give you the true history, habits, diseases and other troubles of our great tormenter, the house-fly. Perhaps such a paper should have been read at a time when the supply of flies exceeded the demand for them, and not now in mid-winter, when, as the commercial papers have it, the market in flies is dull. To study flies we should have them about, so that they can be seen, heard, and felt, as lessons are only well learned by studying the objects themselves.

"The history of the common house-fly has been studied thoroughly but quite recently. The memoirs of the Swedish Count DeGeer, published a little over a hundred years ago, contain the first notice of this interesting insect, while a fuller account was given in an obscure book by Bouche, a German entomologist, published in 1834. Both accounts are far from thorough. Dr. A. S. Packard published his prize essay upon this insect in 1874, this being the first real scientific work upon it. About the same time the question came up: is our fly identical with the house-fly of Europe? Strange to say, when the question arose in mid-winter, all our museums were ransacked for specimens for comparison, and to the great disgust of entomologists it was discovered that not a single fly could be found in any American collection of insects. There was a corner in flies—perhaps the first time in history! Later material was not lacking, and Dr. Packard could not find any difference between house-flies from different countries.

"How long this fly has been living in this country there are no data to show, and it may have sailed on the Mayflower, or buzzed in the cabin of Captain John Smith's vessel, or even performed its measured flight near the ceilings in the ancient town of Pemaquid. At all events, the house-fly is one of the earliest settlers, and is entitled to the liberty it takes every summer with the upper Four Hundred of New York. Perhaps it may have been here before America was discovered; and when Christopher Columbus wiped his brow upon landing on our shores, it may have been ready to settle upon his nose. The fly is impudent enough to have done so, though history does not throw light upon this subject.

"During the month of August the house-fly is particularly abundant, and especially so in the neighborhood of stables.

On placing a fly in a glass bottle she laid, between 6 p. m. Aug. 12, and 8 a. m. next morning, 120 eggs. They were deposited irregularly in stacks, lying loose in two piles at the bottom of the bottle. At 8 a. m. of Aug. 14, several were found hatched and the maggots were crawling about. The egg of the house-fly is long, cylindrical and a little smaller at the anterior end than at the other. It is 0.4 to 0.5 of an inch long, and about one-quarter as thick. The shell is very dense. The eggs hatch twenty-four hours after being laid—in confinement they require five to ten hours more, and the maggots hatched in confinement were smaller than those reared from eggs deposited in warm manure. For several days the worms living in this dry manure did not grow sensibly. Lack of direct warmth, but more especially the want of sufficient moisture and, consequently, of available and semi-liquid food, seemed to cause them to become dwarfed. It is evident that heat and moisture are required for the normal development of the fly, as they are for nearly all insects.

"The maggots moult twice, consequently there are three stages of development, and they become sensibly larger at each stage. After feeding six or seven days the larva is nearly full grown; its body is long and slender, somewhat conical, the head and mounth-parts being rudimentary; the end of the body is truncated, and bears two short tubercles or spiracles, which contain circular breathing holes with sinuous openings, the edges of which are armed with fine projections, forming a rude sieve for the exclusion of dust and dirt. When about to transform into the pupal state, the body contracts into a barrel-shaped form, turns brown and hard, forming a case, within which the larva transforms itself into a pupa. Our house-fly having, as a maggot, lived a life of squalor, immersed in its revolting food, appears after a short pupal sleep of from five to seven days, as a winged being with legs and wings of which before there were no traces, and is animated by new instincts and mental traits.

"If in its winged condition it is one of the most disagreeable features of dog-days and people wonder why flies were ever made at all, it should be remembered that flies have an infancy as maggots, and the loathsome life they then lead as scavengers cleanses and purifies the August air and lowers the death-rate of our cities and towns. Thus, while stables and other filthy places are tolerated by city and town authorities, the young of the house-flies, and of flesh- and blow-flies, with their thousand allies, are doing something toward purifying the pestilential air, averting the summer brood of cholera, dysentery, diphtheria, typhus and typhoid fever, which descend like harpies upon the devoted towns and cities. It may be regarded as an axiom that where flies most abound there filth, death-dealing and baneful, is most abundant, and where filth-diseases such as just mentioned do most congregate.

"When the fly leaves its pupal case, it pushes away the front end of it, which opens like a lid, by means of the distention of the membraneous front of the head, which may be seen pushing out and in as the fly walks rapidly about. When free from its prison the fly runs nervously about, as laboring under a good deal of mental excitement and quite dazed by the new world of light and life about it, for as a maggot it was blind, deaf, and dumb. Now its wings are soft, small, baggy and half their final size. The fluid that fills them, soon, however, dries up, the skin of the fly attains the colors of maturity, and it flies off with a buzz suggestive of contentment and light-heartedness born of its mercurial temperament. Fig. 125, plate X, shows the fly in all its beauty.

"When we consider that each female may deposit as many as one thousand eggs, and that in the course of one summer we may have from seven to nine generations of flies, it should not astonish us that these winged tormenters appear as by magic. The question, why do flies appear suddenly and in such immense numbers, may be answered by the statement that they multiply in a geometrical progression, and that a single female in suitable seasons and surrounded by plenty of food may produce such a number of descendants in one year that to express it requires thirteen figures. But flies have not their own way in everything as will appear later. As soon as the nights become cool, flies try their very best to find shelters for the winter, and no matter how carefully we may protect doors and windows with screens they will find an entrance, to the great worry of our better halves. Sufficient numbers would thus find a shelter and survive the rigors of a northern winter, if they did not bring with them at the same time an enemy they can not escape, and one that will kill the very great majority of all house-flies at that season. Only a few escape this "slaughter of the innocents," and these few are the ones that may be seen during the winter in our houses; others will find wintering quarters under rubbish, and remain in a torpid condition until the warm weather of spring coaxes them back to life. Most flies that escape death in autumn hibernate in their winged form; a few may also winter over as pupæ, though this is doubtful, at least in Minnesota.

"Have you ever observed a genuine house-fly, one with a full pedigree? This question seems absurd, but the writer's experience has been that really few persons can tell the difference between a house-fly and other flies so common in our houses. All flies found upon our walls, upon windows and tables, are called house-flies, yet at least a dozen species are mixed up in that congregation, all widely different, more so than cows and horses. One of the most curious habits of the genuine Simon-pure house-fly is its peculiar position during sleep, and once observed it will always be recollected. When we enter a dark room all flies are sleeping, but only the house-flies sleep with their heads downwards, the others in a more normal position. By bringing a light into the room, you may ascertain very rapidly the proportion of true house-flies to that of other intruders. Notwithstanding our intimacy with the fly, or rather its intimacy with us, how very little is really known of it by the plurality of tormented humanity! Those present always excepted, not ten per cent of our fellow citizens ever know how many legs or wings a fly has or where it spends its early days in infantile sports. How many know why it so suddenly appears in countless numbers to torment the masterpiece of creation, not caring a straw when or where it attacks him? The ministers in church as well as the public speakers, during some of their most eloquent passages, must scratch their noses as freely as does the poor laborer who diligently or otherwise digs trenches for a new gas company. A study of the proboscis of the fly (fig. 126) reveals a wonderful adaptability for its uses and misuses. In this proboscis, we see a fleshy, tongue-like organ, bent up beneath the head when at rest. The maxillæ are minute, their palpi being single-jointed, and the mandibles or jaws are comparatively useless, being very short and small, compared with the lancet-like jaws of the mosquito or horse-fly. But the structure of the tongue itself (labium), is most curious. When a fly settles upon a lump of sugar or other sweet object, it unbends its tongue, extends it and the broad knob-like end divided into two broad, flat, muscular leaves which thus present a sucker-like surface, with which the fly laps up the liquid sweets. These two leaves are supported upon a framework of tracheal tubes; these modified tracheæ end in hairs projecting externally. Thus the inside of this broad, fleshy expansion is rough like a rasp, and, as Newport states, "is easily employed by the insect in scraping or tearing delicate surfaces." It is by means of this curious structure that the busy house-fly occasions such mischief to the covers of our books by scraping off the albuminous polish and leaving tracings of its depredations in the soiled and spotted appearance which it occasions on them. It is by the means of these that it teases us in the heat of summer, when it alights on the hand or face to sip the perspiration that exudes from and is condensed upon the skin. The microscope reveals wonders quite unexpected in such a common insect as the house-fly, but it will take too much time to describe them now in detail.

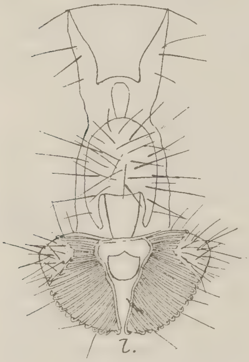


Fig. 126.—Mouth-parts of house-fly. Greatly enlarged. Original.

"The very fact that flies run over our skins in search of liquid food is sometimes the cause of diseases. Bad ulcers, caused by contagious diseases, are visited by flies whenever they have an opportunity to do so. Being hairy insects, and having upon their feet sucking-pads, bacteria found in such sores must adhere, and, if another person is visited in turn, disease-spores will be carried to his skin, and should conditions be favorable the germ of the disease thus brought there will not be slow to act. I had an opportunity some years ago to study the eggs of a tape-worm. These eggs were counted and covered with a watch-glass. A piece of freshly-cut beef was put in another part of the same room, the watch-glass was removed to give the house-flies access to the eggs, some of which, soon afterward, were detected upon the flesh, showing that even larger objects than bacteria can be carried about by these insects.

The following quotation from John A. Ryder in the Entomological News for 1892 will no doubt be of interest:

"Cholera and flies.—It may not be amiss to call the attention of the public to the great danger from house-flies as agents in spreading the contagion should there be an epidemic of cholera. I have repeatedly observed that these insects will ride for a number of miles on street cars, and doubtless also upon other vehicles of transit, such as railway coaches, etc., though I have never made observations upon any conveyances but the ordinary tram or horse car. Suppose a case: imagine a cholera victim upon the street or anywhere else vomiting; the flies present are attracted and drink until sated, and have their feet and mouth parts wetted with the vomit containing the germs. They then, perhaps, fly out into the street, take a place on a horse car, ride several miles, dismount, fly into another house, where the family are at dinner, and contaminate the food set before them with the germs of the cholera carried on the mouth parts and feet of the insects. Some of the family sicken and die, yet no one of them will ever, perhaps, suspect that the flies have carried the germs, as supposed above, for miles from some other case. The safeguards are to at once clear away, disinfect with corrosive sublimate solution and scald the spots where the vomit has been thrown, and to be vigilant in the use of fly-screens, fly-traps, etc. During the late war the late Professor Leidy pointed out, with beneficent results, that the common house-fly was instrumental in spreading the contagion of hospital gangrene. Why not beware of this imprudent and ubiquitous little dipter in carrying and spreading the contagion of the dreaded Asiatic plague now menacing us?"

"During the months of August, September and October, but mainly during September, it is a very common occurrence to find dead house-flies adhering to the walls, window-panes and other conductors of heat, firmly fixed by their proboscis and with the legs spread out in quite an unnatural manner, thus differing from dead flies in general which have the legs contracted. In about twenty-four hours after death a kind of fatty substance of a white color is found in the form of a ring projecting out between each of the rings of the

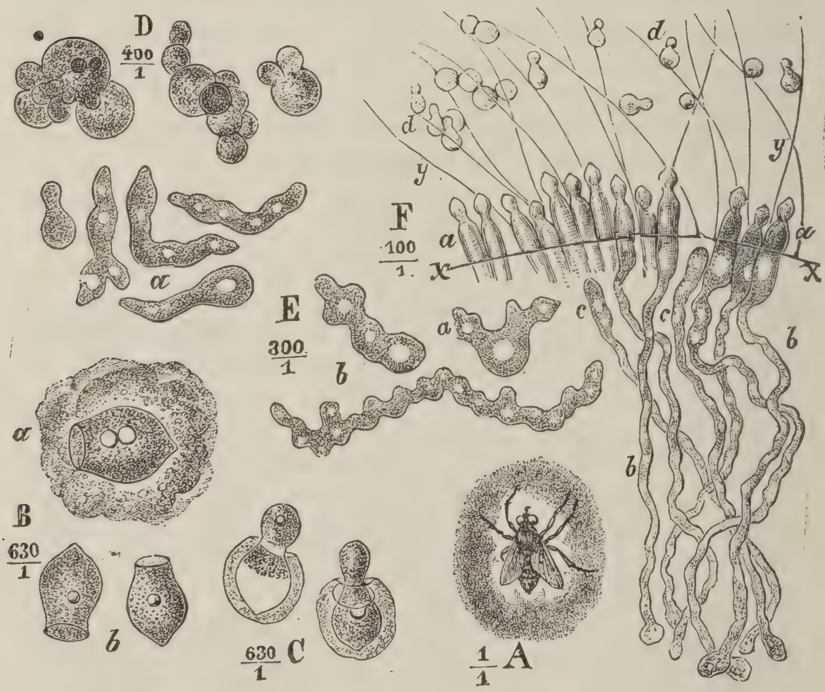


Fig. 127.—Disease of house-fly. Greatly enlarged.

abdomen, and in a day or two after the whole will be found dried, and the surface of the wall or glass lightly covered in a semi-circle, at about one-half to one inch from the fly's abdomen, with a cloud of whitish powder. This whitish, fatty substance is found on examination to consist of a vast number of short, erect filaments growing out from the body of the fly, between the rings. These filaments contain large oil-globules, often arranged in a row, and these having been mistaken for spores gave origin to the name of *Sporendonema*, applied to this fungus. Mr. Cohn has described its growth somewhat minutely and changed the generic name to *Empusa*, or rather *Empusina*, the first of these names being already appropriated. He states that the vesicle filaments terminate in the abdomen in a continuous, often branched tube and consist therefore of a single tubular cell. The upper free end, however, becomes cut off by a septum, and the terminal cell acquires a campanulate form and a dark color; when ripe it is thrown off with some force, and a number of these form the white cloud above mentioned. Fig. 127 shows these parasitic plants. You have all no doubt observed this halo or oriole surrounding a dead fly fastened to the window or looking-glass.

"Mr. Cohn endeavored in vain to make these spores germinate; and nothing like them were found in the cavity of the abdomen of numerous flies in which the filaments were traced in their earlier stages. Mr. Griffith inclines to regard them as peridioles or spore-cases; or they may be stylospores, which after a stage of rest produce an intermediate mycelial structure, and then give birth to the ripe spores.

"When we turn our attention to the poor sufferer, we observe no outward signs of the disease in its early stage; yet watching carefully great numbers of flies we soon detect some that differ from the rest by a more erect abdomen and by their awkward way of walking. At first they are restless, constantly running and flying about; if the disease, however, grows worse, their motions become very sluggish, and if you approach them with your fingers they either do not fly away at all or in a very clumsy way, soon settling again. At last they are unable to walk more than a few steps. About an hour before they die, all intentional motion ceases, and the fly fixes its proboscis firmly to the object it happens to have settled upon, only the legs spasmodically contract and extend in a very unsymmetrical way, as shown in the illustrations, figs. 127 and 128. The abdomen gradually swells and shows on its underside a whitish color; the upper surface of the insect, however, does not change at all, and no trace is as yet visible of the white rings between the segments, nor is any white dust to be seen. Gradually all motion ceases, and the animal is dead. After death the abdomen still swells, and about eight hours afterward it is so much distended that the segments are pulled apart, and the fine connecting skin between them becomes visible, and here a white substance is gradually pushed out from the interior, so that eventually three white and parallel rings or belts are formed. The first trace of loose dust becomes now visible under the insect. The fly remains unaltered in this condition for several days, only these belts become more prominent, and frequently a white ring is also visible between head and thorax. The dust around the dead fly becomes denser, the corpse eventually dries up, the white belts disappear, and the body shrinks so that the fly looks like a living one, though wings and legs are covered with dust (fig. 128, plate VII). Thus far all the symptoms could be followed with the naked eye, but the microscope alone can give us an explanation of the whole process.

"Being afraid that, by this time, you will be thoroughly sick of the *Empusa*, I will not inflict upon your patience the history of the microscopic influenza, another disease that attacks our domesticated fly. It goes by the name of *Isaria*, was first discovered by Meigen, and has but one good point about it—it kills flies.

"To wind up this already lengthy discourse upon diseases of flies, let me only mention some other enemies—besides yourselves—of this troublesome intruder to an afternoon's snooze, knowing that it will please you to hear that the life of the fly is far from being an eternal round of revelry and pleasure, and that it is troubled in more than one way.

Several kinds of true worms (*Nematodes*) are found in the house-fly. Sometimes they are very numerous, and if the detached head of the fly is pressed between two flat pieces of glass they can readily be seen. As many as seventeen have been counted in the head of a single fly, and it is no wonder that this fly showed all symptoms of insanity, being perfectly reckless and very erratic in all its motions. It is preyed on in Europe by two kinds of ichneumon-flies, whose larvæ feed inside of their host; also by a fly-parasite (*Astoma parasiticum*). It is a pity that these useful parasites have not as yet been introduced into this country. We already possess, however, one fly-parasite in this country (*Astoma muscarum*) (fig. 47). You have no doubt seen small red dots upon the base of the wings of our fly (fig. 46, plate VII). This red dot is the parasite just mentioned, and let us hope that it may increase at the same ratio as all his relatives are in the habit of doing. Fig. 129 shows house-flies and blow-flies upon a bone; also their earlier stages."

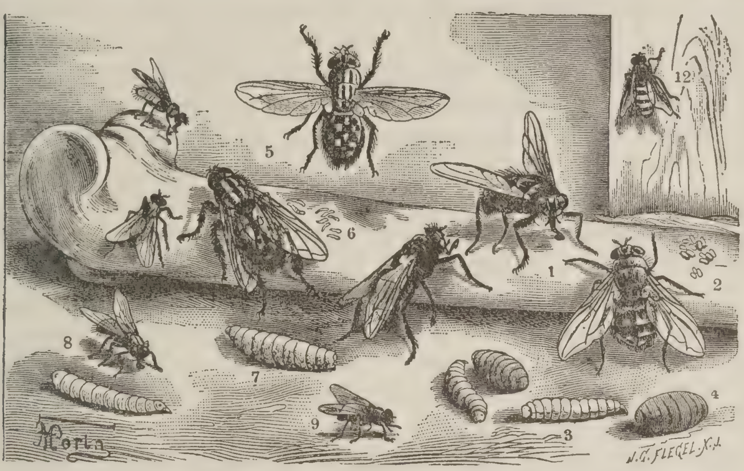


Fig. 129.—Different stages of house and blow-flies. Enlarged. After Taschenberg.

THE BLOW-FLY OR FLESH-FLY.

(*Sarcophaga carnaria* Linn.).

Many other flies, although they do not actually bite man or beast, become a great nuisance and torment by running over them in search of liquid food, perspiration. Nearly all species of blow-, meat- or flesh-flies belong here. But some of them are not satisfied with simply trying to obtain food for themselves, but take care of their offspring by dropping either eggs or larvæ upon the host. Many species of blow-flies have this habit, and as they produce living young and as these increase rapidly in size, they can cause trouble, even death. The viviparous females retain the eggs in spiral dilations of their oviducts until hatched, when they are deposited upon decaying flesh of all kinds. The sexual organs of the horse, cattle, and hogs, the interior of the ears, but principally wounds and sores are selected by such flies and here they drop living maggots in large numbers. Whoever has observed even fairly fresh meat exposed for but a few moments in places where blow-flies abound must have seen the innumerable small heaps of very minute maggots deposited upon it. The female flesh-fly (*Sarcophaga carnaria* Linn.) can deposit at least 20,000 of these maggots, and as they grow very rapidly they consume a large amount of food, and forcing their way into the festering substance about them they soon enlarge sores ("living sores"), and make them very dangerous. All these flies multiply very rapidly, producing many generations during the course of a warm season. It has been computed that a single female, within six months, can have 508,000,000 descendants. No wonder, then, that they can devour the carcass of a large animal in a few days, and that we have so many flies about dwelling-places and stables not kept clean.

The maggots of these flies grow so rapidly, if food is plenty, that from a mere speck they grow in two or three days to half an inch in length. They are whitish, long, soft-bodied, footless, and are smaller towards the head and thicker and blunt behind. When full-grown they leave their odoriferous food and crawl to some convenient spot, force their way into the soil, where they contract into elongated-oval, barrel-shaped, and reddish-brown puparia, inside of which the adult insects are formed. This requires but a very short time, a few days, and the winged fly issues ready to start another generation. Fig. 130, plate X, illustrates this common insect.

All blow-flies can become the authors of epidemics. Dr. Maddox read a paper before the Royal Microscopical Society, in which he detailed the results of experiments especially about the relations between the common-fly and the *comma bacillus.* According to the Scientific American the results of all his investigations lead him to believe that the *comma bacillus* from cultures can pass in a living state through the digestive tubes of some insects, and through this fact, that such insects are likely to become an important means of distributing disease, especially to animals that feed upon them. This is in accordance with the views of Dr. Grossi, that "insects, especially flies, may be considered as veritable authors of epidemics and agents in infectious maladies."

As these flies deposit their eggs on open sores or upon wet, filthy parts of the skin, serious trouble may be caused. To prevent this all wet and filthy hair should be cut and the wounds should be kept clean and rendered antiseptic. A good lotion for this purpose is made by mixing one part of carbolic acid with fifty parts of water; or a mixture should be made of one ounce oil of tar and twenty ounces of sweet-oil.

It is stated from time to time that maggots have been vomited from the human stomach. Such maggots are the young of blow-flies or of other similar flies which may have been swallowed in some way, and as they can exist for some time in the stomach and intestines they can cause serious trouble. The mysterious fly-disease (*Myiasis*) is caused by the presence of such maggots in the interior of human beings.

The maggots of *Sarcophaga latifrons* have repeatedly been removed from ulcers in the ear, and other cases have been reported where such maggots had destroyed vision by penetrating to the eye.

About the very worst of such flesh- or blow-flies is the Texas screw-worm, an insect that has a very bad reputation, and what is worse, one that is well-earned. As this insect is also found in Minnesota, and has already done some harm, it is best to describe it more in detail.

THE SCREW-WORM.

(*Campsomyia* (*Lucilia*) *macellaria* Fab.).

This fly is a flesh-fly with the additional bad habit of being very impatient, as it does not always wait until the animal is dead that is to furnish the food for the offspring. As a general rule, it lives, like all its relatives, upon decaying animal and vegetable matter in and about which it undergoes all its transformations. The eggs, about one-sixteenth of an inch long, of a light yellow color, are deposited by the female on or near dead animals. The mother must possess wonderful organs of smell, or of some other sense, which enable her to detect such food, even if well hidden or obscured by other odors. These eggs being quite soft, would soon be destroyed by the direct rays of the sun, hence they are deposited under the carcass, or on its shady side. Such flies are known to contain as many as 20,000 eggs in their ovaries. These eggs hatch in one or two days, depending upon the length of the time that they were retained in the ovaries by the mother-fly before discovering the proper food for her young. The dirty-white larva possesses the usual form of fly-maggots; a ring of bristles between each pair of segments gives the maggot a fancied resemblance to a screw, hence the above popular name. These bristles act as legs in locomotion. The mature maggot is three-fourths of an inch in length, and about one-eighth of an inch in diameter; it possesses a tapering head, that contains two pointed black hooks, which are the mouth-parts used to obtain food. The posterior end of the maggot is very much truncated. The maggots grow very rapidly and reach their full size in four to six days, when they leave the substance upon which they have fed and enter the ground, where, just below the surface, they contract into dark-reddish and barrel-shaped puparia, about one-third of an inch in length. Inside such a puparium the fly is formed, which takes about 7 days, when it leaves both the puparium and the ground to fly about and enjoy life according to its peculiar fashion. This fly (fig. 131, plate XI) is a very beautiful insect, a little larger than our common house-fly, of a bright metallic green color, and having prominent dull-red eyes; its back is marked with three distinct black stripes running from head to abdomen. When leaving the pupa the fly is gray, but very soon it assumes its glittering uniform, and the female is able to deposit her eggs the second day after emerging.

The above life-history does not vary from that of any other flesh- or blow-fly. But the screw-worm attacks also living man, dogs, sheep, cattle, horses, and even fowls, and if it succeeds in forcing an entrance into the body of such hosts it causes the most excruciating pains, and not unfrequently death. Its points of attack are the sheaths of male animals, the navels of new-born stock, and any abrasion of the skin. In man those suffering from a severe cold are most apt to be attacked by these flies, which were formerly called the "man-eating flies" (*hominivorax*) on account of their devouring man. In or near wounds found upon animals, or in nostrils and other openings, they deposit their eggs which immediately or very soon afterwards hatch. The young and active maggots force their way into the flesh, feeding and growing as they go, and thus rapidly enlarge the sores. They are soon out of sight and revel now in living flesh, until the wounds enlarge to such an extent, if not discovered and treated in time, that the infested animal has to die. If such maggots enter the nostrils of man in numbers they are very apt to kill him unless steps are taken at once to remove them.

In regions where such flies are common great care should be taken not to expose wounds and sores, as these flies have been observed to deposit their eggs in them while they were being dressed. For the same reason persons should never sleep out of doors, nor unprotected by mosquito bars, wherever such flies abound.

But it is not in the south alone that these flies occur. We have them in our state as well, though they have caused but few injuries, being here in fact rather beneficial as scavengers. Several cases are, however, on record, in which their larvæ have been found in the human ear.* In other cases fowls suffering from cold were killed by these maggots; they were eaten alive, so to speak.

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*Dr. Howard McI. Morton, of Minneapolis, reports two cases which he treated in 1895.

The best way to prevent losses among our domesticated animals is to give them the proper care they deserve, and to pay prompt attention to their health. All sores should be attended to as soon as discovered, and should be carefully cleaned. By permitting no filth, no matter of what character, to accumulate, we prevent the increase of such suspicious and dangerous insects. Carcasses of all kinds should not be simply dragged into the woods, or some distance away from houses, to decay there, but should be promply buried, and deep enough that no maggot or the resulting flies bred in them can ever reach the light of day. Maggots of all flesh-flies are very tenacious of life, and even an immersion of several minutes in pure carbolic acid and strong turpentine does not kill them; even chloroform and ether do not kill them at once. Whenever persons or animals become infested with such dangerous maggots a physician should be consulted without delay.

The use of fresh pyrethrum (insect-powder) is claimed to be a very good remedy. Of course all maggots that can be reached with an instrument should be removed by mechanical means.

THE STABLE-FLY.

(*Stomoxys calcitrans* Linn.).

This fly, so frequently mistaken for the troublesome, restless, but otherwise innocent house-fly, is no stranger to our habitations; in fact it takes possession of our rooms without having been invited. If it behaved as a visitor is expected to do matters would be all right, but this impudent fly is not satisfied, like the house-fly, with anything we may have upon our bill of fare, but it requires more precious food, human blood, and is not slow to take it whenever it pleases. We often hear the complaint made that house-flies would bite most viciously whenever rain was approaching, and during and after a shower. There is no doubt about such bites, but they were not inflicted by our domestic friend, the house fly, but by the above intruder, the stable-fly. As the name tells it is an insect most commonly found in and near stables; here, when at all numerous, they cause considerable irritation to the animals confined there and in extreme cases these become frantic with pain and unmanageable.

The stable-fly (fig. 132, plate XI), found most abundantly late in autumn, resembles very closely a house-fly, but can be distinguished from it by its pointed proboscis projecting in front of the head (fig. 133) and by its feathered feelers.

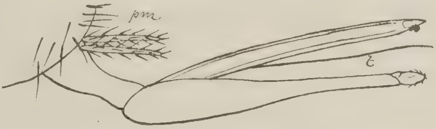

Fig. 133.—Mouth-parts of stable-fly. Greatly enlarged. Original.

Its general color is gray; the anterior half of the thorax possesses four darker stripes, while the posterior half is spotted. The abdomen, with a yellowish-brown cast, has upon the second to last segment three brown and poorly-defined spots. It seems as if this fly produced but a few generations each year. The maggot, very similar to that of the house-fly, has a somewhat different head, and can be distinguished readily by the fact that the two posterior spiracles possess three openings arranged in a triangle, while the former has but one. The larval stage of this very annoying insect is passed in horse-manure, though it has also been found mining in the leaves of various plants (Taschenberg).

4.—Tsetse-fly. A modern and Bruce's original illustration. Enlarged.

A fly related to the stable-fly, and also similar to the breeze-fly, has a particularly bad reputation; it is the Tse-

TSE-FLY (*Glossina morsitans*), which is said to be so dangerous that whole regions in Africa are uninhabitable during the season in which they are numerous. The mortality caused by them is no doubt due to a disease disseminated by their attacks. Bruce, in his travels to discover the source of the Nile, in 1790 first figured this insect, and a copy of it is shown in fig. 134, while a more modern one is also given to the left.

He gives in the books published by him a very interesting account of its mode of life, and a still more interesting historical sketch of the changes produced by it in the political history of the countries in which it abounds.

THE BLUE-BOTTLE-FLY.

(*Calliphora vomitoria* Linn.).

This beautiful fly, beautiful in colors but not in manners, is known to everybody. It can not be classed as a parasite, or as infesting man and beast. It is very frequently found in our houses, usually trying to run its head through the glass of our windows, and as constantly complaining about the hardness of the latter by a deep humming sound. But when we ask those in charge of our eatables they will complain bitterly about this insect which loves meat of all kinds and is very apt to spoil the same in more than one way. It is shown in fig. 135, plate XII.

THE HORN-FLY.

(*Hæmatobia serrata* R. Desv.).

This insect is a recent acquisition, and one we could well do without. It reached this side of the Atlantic coast, according to Prof. John B. Smith, the well-known entomologist of New Jersey, either in 1886 or in 1887, and soon spread westward. In 1892 the writer noticed it in large numbers in Otter Tail County, and was told that it had there troubled cattle for some years. Mr. L. A. Foote, of Worthington, Minn., a very careful observer, told me very late in the fall of 1895, that it had been common in that vicinity long before 1886, and to demonstrate that he knew the insect he went, in the dark, to his cattle-yard and returned soon after with undoubted specimens of horn-flies. This would indicate that the insects had been introduced before, but had remained unnoticed.

Owing to a series of very dry summers the insect is no longer as common and troublesome in Minnesota as it was a few years ago. It is confined to cattle which it torments day and night in the stable or in the pastures. The flies burrow among the hair, preferring the region about the shoulders and the root of the tail, though other portions do not escape. While biting the flies spread out their wings in a peculiar way, and do not keep them closed as do the stable-flies. The flies have still another peculiar habit which caused them to be called "horn-flies." They cluster about the horns, especially their bases, and frequently encircle them as a broad ring. This position is selected to rest, and not to injure the horns, as has frequently been claimed; in fact their mouth-parts could not penetrate such hard material, being constructed simply to suck blood. This blood-sucking habit, the constant irritation caused by it, and their running about over the skin, prevent the cattle from feeding, disturb quiet digestion, and as a consequence cause a falling off in milk and cream. Some cattle suffer less than others; and if equally infested with these tormenters some animals will quietly remain chewing their food while others become frantic.

The small fly, about 4mm. long (a little over one-sixth of an inch), is of a dark ash-gray color with a faint tinge of yellow. As the insect is illustrated (fig. 136, plate XII) it is not necessary to describe it in detail.

The life-history of this pest may be summed up as follows: the white egg, 1.5mm. long, elongate and a little curved, turns brownish before hatching. The white and footless maggot, which soon hatches, tapers toward the head and terminates abruptly behind, where it is furnished with a pair of black spiracles. When mature it measures about three-eighths of an inch, and is of a dirty yellowish-white color.

Like all maggots of this family of insects it moves by contracting and extending its body, and is assisted by a double row of peculiar fleshy mobile organs on the last six segments. The larva or maggot is very active and soon reaches its full size, when it contracts in the usual way and becomes a reddish-brown puparium, less than half its former length. The whole life-cycle from egg to fly requires but twelve to fifteen days.

Tobacco-powder dusted among the hairs is a fairly good remedy; it will not entirely prevent the fly from settling upon the animal, but will repel them before they have had time to bite. Other remedies will be given later. The true remedy, however, is to prevent these flies from breeding, and this is not such a very difficult matter as it might seem. The larvæ of this fly can exist only in soft, almost liquid manure. All that is necessary to do is to accelerate the drying of this food, a matter not at all difficult in our usually dry summers. This may be done by spreading all fresh droppings every day, when the moisture will be absorbed and the food will become too dry for the maggots. Neither would a general distribution of such manure destroy the value of the same. The liberal application of plaster to the manure removed from the stable, in which eggs were deposited, as well as in the manure-heap, deprives the maggots of food and at the same improves the value of the fertilizer. Cleanliness is as essential in stables as elsewhere, and clean stables do not possess the attraction for such insects that the neglected ones do. To make the remedy of depriving the maggots of appropriate food as effective as possible united and persistent action throughout the invaded region is absolutely necessary, and it should be put in operation very early in summer, for if postponed until late it will not be of much benefit.

All flies mentioned thus far, with the exception of the horn-fly, can become exceedingly dangerous to man and his servants, the domesticated animals, in another way quite independent from their bites. All are buzzards on a small scale, and remove much of the disease-breeding material apt to be found near the domicile of man. Being scavengers they must necessarily come in contact with dead animals, which may have been killed by a contagious disease, and thus they may carry away on their bodies disease-germs of all kinds. Settling again upon a healthy being they may communicate such a disease by contact. In this manner diseases have been carried about by such flies. Again some of them can eat the eggs of various parasitic worms, and discharge them unharmed with their fæces. It has been demonstrated that several internal parasites of man have thus been distributed. Dr. Grassi has shown that the eggs of the tape-worm (*Tænia solium*) and of *Tricocephalus dispar* were carried by the common house-fly.

How to protect man and animals against flies in houses and stables is not an uncommon question. It is not difficult at all to prevent all such tormenters as house-flies, stable-flies, flesh- and blow-flies, mosquitoes and others from biting us in our homes, or our domesticated animals in their stables, nor is it very expensive. Persian and Dalmation insect-powder, or Buhach, is a most excellent substance for this purpose, and if not too old or too much adulterated will succeed. It can be applied in several ways; as a powder or as fumes. The former should be blown in the air; the latter should be burned upon an old saucer or plate. A very nice way is to form the finely powdered and slightly moistened pyrethrum into cones, which after being dried in an oven can be ignited at the apex, when they will slowly burn and give off the deadly fumes. Only a small amount is required, providing the doors and windows are closed, the quantity depending upon the quality of the powder. All flies in rooms or stables will soon show the effects of this insect-powder; they either die from it, or become too disabled to do mischief for quite a while.

According to the "Denver Field and Farm" of April 25, 1896, a machine for catching flies from the backs of cattle, and so affording the animals relief and comfort, has been invented by a farmer in Madison County, Kentucky. The fly-catcher is a kind of covered pen or passageway, through which the animal must walk to secure relief. A few feet from the entrance there is a cupola, or dome, in the roof of the passage-way, made of glass and arranged as a fly-trap. Beyond this the passage-way is in darkness. The animal walks through the machine, and just as it passes the dome and enters the darkened part a set of brushes sweep off the flies, which naturally rise into the lighted dome, and the steer passes out at the other side free from flies. The flies are retained in the dome trap. The inventor has experimented with his machine, and finds that animals soon learn the value of it and know enough to walk through the same when the flies begin to bite. The device is said to be patented, but a plan involving the same principle has been in use among farmers for the destruction of horn-flies for a year or two past.

GAD-FLIES. BREEZE-FLIES.

(*Tabanidæ*).

There is quite a large family of flies the members of which have gained for themselves a very bad reputation. They are usually called Gad- or Breeze-flies. Such flies are found everywhere, and each climate has its own species, but all possess the same blood-thirsty character and attack warm-blooded animals, be they lions in the torrid zone or reindeers in Lapland, and none escape their attacks, be they domesticated oxen and horses or wild and swift-footed moose and deer. The family is distinguished by a broad and slightly flattened body, by a large head depressed from front to rear, by very large eyes, which are contiguous in the males, and which are frequently beautifully colored, by a thick and compact thorax, with a large and elevated scutellum, and by legs whose tarsi are furnished with three cushions. The last joint of the feelers is annulated but has no stylet; the exerted proboscis of the female encloses six lancet-like instruments, while that of the male possesses but four; it ends in two fleshy and lip-like lobes and is covered on the sides by the large two-jointed maxillary palpi. The wings, which extend horizontally, are propelled by powerful muscles and contain a larger number of veins than is usual in flies. The flight of these flies is very rapid and accompanied by a buzzing sound which greatly alarms animals hearing it.

Only the females of Gad- or Breeze-Flies attack animals; the males live on the sap of flowers. These insects are most commonly found in the neighborhood of marshes, and our prairies with their numerous low and swampy places abound in them. Woods and pastures are also frequently visited by them. This is accounted for by the fact that the early stages of this insect are passed below the ground, in wet soil, and even in water. Their eggs are brown or black, spindle-shaped, and are deposited in groups upon aquatic plants and stems of grass. When the sun is very hot in summer these insects are most active, and thousands of them fly about, and frequently torment the larger animals to such an extent as to make them perfectly wild and frantic. The moose and deer, attacked by such tormenters, lose all fear of man and plunge into rivers and lakes to escape their attacks; they soon become very poor, as they have no rest to feed excepting at night. Even the most rapid animals can not escape these swift tormenters, which descend upon them and, choosing the most tender portions of the skin, bury their powerful proboscis (fig. 137) in it and do not withdraw it until satisfied with blood. A slight swelling, which soon disappears, shows where the skin is perforated. Their flight is so rapid that they can not only follow an express train but can make excursions into the country at the same time. This is frequently seen when one of them settles upon the window of a fast train in motion, and after awhile darts off some distance soon to return to its resting-place. It is believed that such flies are agents in transmitting virulent diseases, when they leave an animal affected with one of them and introduce their proboscis into the skin of a healthy one.

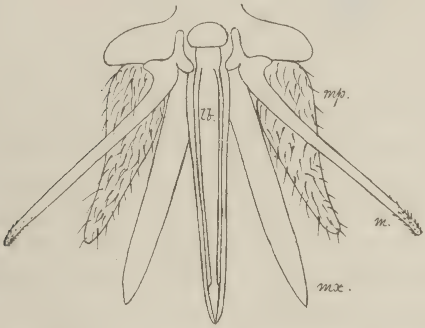

Fig. 137.—Mouth-parts of Tabanus. Greatly enlarged. Original.

We have a large number of such insects in Minnesota, but all possess a very similar life-history, at least as far as we know. In our southern counties the "*Green-head*" (*Tabanus lineola* Fab.) has a very bad reputation and further south in the Mississippi valley it is sometimes impossible to work horses in midsummer without a protecting covering. In fact cases are on record that horses fastened to a tree or a fence were bitten to death. This fly is illustrated in fig. 138.

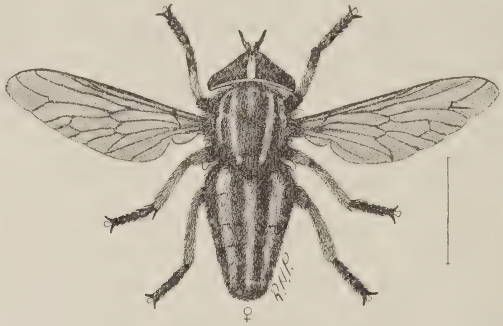

Fig. 138.—Green-head. Greatly enlarged. Original.

"*The Black Breeze-fly*" (*Tabanus atratus* Fab.), though found in Minnesota, is not common, hence causes less trouble to cattle, which it prefers to horses. Its large larva is found under stones in water, where it feeds upon other aquatic animals. The most common of our breeze-flies is illustrated in fig. 139, plate XIII. It is "*Reinwardt's Breeze-fly*" (*Tabanus reinwardtii* Wied.). This fly, less blood-thirsty than the two mentioned above, is found in immense numbers in our prairie region. It sometimes gathers in the small railway stations in such numbers on the window-panes that no light can fall through them, and the writer counted upon one window, and below it upon the bench, the astonishing number of 2117 flies. Why they should remain and die in such places is difficult to explain; at all events these rooms acted as traps, and the flies had not sense enough to escape by the open door, but battered their heads against the glass in their vain efforts to force their way out. The larger breeze- or gad-flies attack only larger domesticated animals, such as horses and cattle. The genus *Chrysops* is distinguished from *Tabanus* by possessing three simple eyes, which are readily seen on the top of the head. The scientific name is derived from the beautiful golden-yellow eyes, with purple lines and spots, which these flies possess. As seen in fig. 140, plate XIII, which illustrates the most common kind found in Minnesota, the *Chrysops æstuans* v. d. Wulp., the insect is also quite ornamental in general appearance, being spotted and banded with pale yellow and white.

A number of different kinds occur in Minnesota; all are very prettily marked insects, with wings wide apart, and with a flattened abdomen, square-shaped almost to the posterior end; the wings are colored with large hyaline spots.

Notwithstanding their beautiful eyes and bright colors these flies are a great pest, and when at all numerous, stock of all kinds suffers very greatly. Man does not escape, and those who are in the habit of bathing in rivers and lakes know to their sorrow that such flies are always lying in wait, and are not slow to attack them; they find their victims even before they have had time to undress, and the long proboscis of these blood-thirsty tormenters can be felt even through the undergarments. If they are at all numerous, bathing becomes a luxury that one can not enjoy at all in the open air. Animals also suffer greatly from their attacks, and they frequently make horses so frantic with apprehension and pain that they will run away. It seems that some prefer to puncture the domesticated animals around the eyes, and one species has on that account been named the "blinding chrysops."

Like the gad-flies these insects are most numerous in the neighborhood of their breeding places, *i. e.* regions with low and moist places, in which the early stages of these flies are passed.

There is another family of flies which is reputed to attack man and domesticated animals for the sake of abstracting blood. This family (*Asilidæ*) contains a number of blood-thirsty flies that resemble wasps, having a brownish-yellow thorax, a narrow and very elongated abdomen with variously colored wings, and very long feet, of which the first pair can grasp the insects they kill. They are very common in Minnesota, but attack only insects, chiefly such as move slowly. One species becomes very destructive to bees, by selecting those that are carrying a very heavy load to the hive; it has received the very appropriate name of "bee-killer." Their reputation of being tormenters of warm-blooded animals is badly founded, however; at least the writer has never observed them sucking blood. If kept between the fingers these flies are not slow to inflict a very severe bite. But other flies, for instance the members of the family *Bombylidæ*, small and very hairy insects with bright colors, do the same thing, and will not permit themselves to be handled with impunity.

There are a number of very small flies that sometimes attack man and domesticated animals, and which notwithstanding their small size, can cause considerable irritation and inflict no little pain.

THE BLOOD-SUCKING OSCINIS.

(*Oscinis pallipes* Loew).

This minute fly, illustrated in fig. 141, is a polished black insect, with yellow face and legs. It is small, as can be seen by the hair-line in the illustration, which gives the natural size of the insect with expanded wings. During June, July and August this fly is exceedingly abundant in some places, and large numbers of them attack such animals as horses, cattle and dogs. They are very quick in all their actions, and can not be readily driven off, always returning and try-

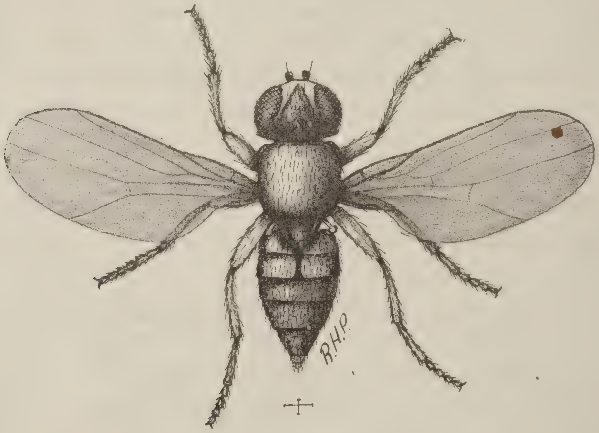

Fig. 141.—Blood-sucking Oscinis. Greatly enlarged. Original.

ing to find a suitable spot to insert their long proboscis. They usually select places where they are protected by hairs, and soon cause the blood to flow over the infested area. When filled with blood they drop to the ground, being almost too heavy to fly. Other flies of the same kind, attracted by the blood, are sure to add to the previous injury, and soon large sore spots are the consequence, which are always crowded with new and hungry insects. They can, when numerous, make the infested animal perfectly wild and unmanageable, and those that can reach water invariably make for it, so as to escape their tormenters. Man does not escape, though in his case usually only the exposed part, the head and hands, can be bitten.

This fly belongs to a family of insects which are, as a general rule, plant-feeders, and some species of *Oscinis* are known to be very destructive to our small grains and to our vegetables. Whether the early stages of this "Yellow-legged Oscinis" are also passed as vegetable-feeders the writer does not know, but it is very likely that such is the case.

THE "NO-SEE-UM" OR "PUNKIE."

(*Ceratopogon spec.*).

This is another fly that is very aggressive, attacking man and domesticated animals wherever it can. It is well-named by our Indians the "No-see-um," being so very small that it can only be felt but not seen. It is a mere speck of matter, and it is difficult to understand how this small being can harbor the vast amount of "cussedness" it is known to possess. As the illustration (fig. 142) shows, it is well equipped with a biting mouth, and those that have ever visited the northern lakes and woods know from experience that the insect knows how to apply this tool. Whenever these flies light upon the hands and face they immediately insert this proboscis in the flesh, and judging from the burning sensation these bites cause, a large amount of poison must be injected at the same time. Where these tormenters abound the finest scenery loses its attraction, and the disappointed visitor leaves the spot with some forcible expressions —if not spoken with his lips they are nevertheless thought.

Dr. L. O. Howard, the chief entomologist of the Department of Agriculture, to whom the writer applied for specimens, writes:—"I have seen specimens in the New York mountains, but have always found that reflex action was too strong for scientific instinct, and I have unfortunately smacked and smashed them instead of putting them in a cyanide bottle for preservation; there are no specimens in the national collection." Prof. Comstock has kindly furnished a slide upon which some of these tormenters have been mounted for the microscope, and from this slide the above illustration has been made. They are of a yellowish color, have transparent whitish wings with darker hyaline spots, as shown. According to Prof. Comstock the larvæ of these minute beings are found living under the bark of decaying branches, under fallen leaves, and in the sap flowing from wounded trees.

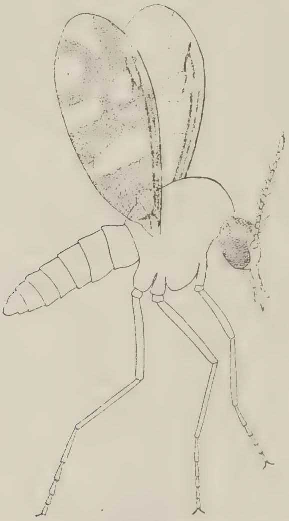

Fig. 142.—"No-see-um" or "Punkie." Greatly enlarged. Original.

BUFFALO-GNATS, BLACK-FLIES.

(*Simulidæ.*)

The family of *Simulidæ* furnishes a large number of flies that attack man and domesticated animals.

The flies belonging to the genus *Simulium* possess a heavy body, bulging thorax, eleven-jointed feelers, of which the first two are separated from the rest; the broad abdomen is rather short; the legs are powerful with broad tarsi; the wings are broad and short. The body of these insects is invested with a fine downy covering; the males are darker and more velvety, and possess broader and more hairy legs than the females. The mouth-parts are very curious, and Prof. J. B. Smith has demonstrated that the female, which is the only one that sucks blood, possesses beside the usual sucking organs, genuine biting mandibles.

These small flies breed in rapidly flowing water, hence are very numerous in the northern part of our state where streams abound. The adult flies are well-known tormenters, and occur sometimes in such numbers as to prevent travel. Prospectors, and surveyors, though usually thick-skinned by living constantly out of doors, have been repeatedly forced to leave a region thus infested. They even force the Labrador fishermen to the coast in summer, as it is impossible to live in the interior on account of these tormenters. Prof. A. S. Packard, in "Our Common Insects," relates his experience in the following words:—"During a summer residence on this coast, we sailed up the Esquimaux River for six or eight miles, spending a few hours at a house situated on the bank. The day was warm and but little wind blowing, and the swarms of black flies were absolutely terrific. In vain we frantically waved our moth net among them and after making a few desperate charges in the face of the thronging pests, we had to retire to the house where the windows actually swarmed with them; but here they would fly in our faces, crawl under our clothes where they would remain and bite in the night. The children in the house were sickly and worn by their unceasing torments; and the shaggy Newfoundland dogs, whose thick coats would seem to be proof against their bites, ran from their shelter beneath the bench and dashed into the river, their only retreat. In cloudy weather, unlike the mosquito, the black fly disappears, only flying when the sun shines. The bite of the black fly is often severe, the creature leaving a large clot of blood to mark the scene of its surgical triumphs."

Such tormenters are also exceedingly annoying in the northern part of Minnesota, and especially near Lake Superior. "Neither the love of the picturesque, however, nor the interests of science, could tempt us into the woods, so terrible were the black flies. This pest of flies which all the way hither had confined our ramblings on shore pretty closely to the rocks and the beach, and had been growing constantly worse and worse, here reached its climax. Although detained nearly two days, yet we could only sit with folded hands, or employ ourselves in arranging specimens, and such other occupations as could be pursued in camp, and under protection of a "smudge-" One, whom scientific ardor tempted a little way up the river in a canoe, after water plants, came back a frightful spectacle, with blood-red rings round his eyes, his face bloody and covered with punctures. The next morning his head and neck were swollen as if from an attack of erysipelas."

The above quotation, from "Lake Superior" by Louis Agassiz, applies equally well today to the same locality, as experienced by such energetic entomologists as N. G. Hubbard and E. A. Schwartz, who tried in vain to collect insects while black flies were out in force.

Nor do such flies exist only in the north; they are as blood-thirsty in southern regions, and whoever has traveled in the tropics will have some very painful recollections of these pests, which are there usually called "sand-flies." In the southern part of the Mississippi Valley cattle, horses, mules, and even fowls suffer terribly and many are killed outright. The common Buffalo Gnat (*Simulium meridionale* Ril.) is a very large species which appears more or less suddenly in large numbers, and as they gorge themselves with the blood of animals, these soon succumb. The loss of blood, together with the terrible irritation of the skin caused by the poison injected, is sufficient to kill in a very short time even such proverbially tough animals as the mule. All domesticated animals know this their worst enemy, and try to escape, but usually in vain, as the attack is always made very suddenly and unexpectedly. Farmers in the region infested by such gnats resort to smudges, which repel these insects to some extent; dark stables are also a partial protection, also greasing with strong-smelling oils.

Nobody can realize the beauty of a southern scenery who has not been there during plowing-time and when the buffalo-gnats were out in force. Just imagine a mule coated with stinking oil, or painted with mud or molasses, pulling a plow from which is suspended a tin pail containing a smudge, while the mule is further adorned by another tin-pail suspended from its neck; the latter contains also glowing embers in which are produced such fine odors as can be made by burning leather and similar substances.

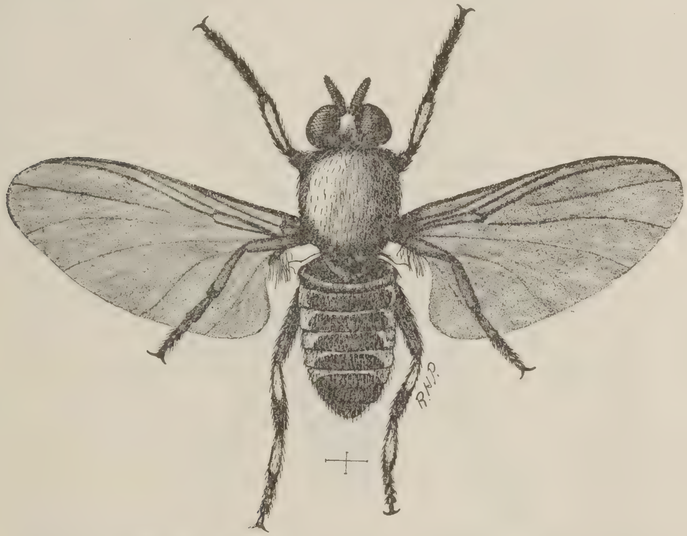

Fig. 143.—*Simulium minutum*. Female. Greatly enlarged. Original.

The losses caused by this insect are, in some years, very great, and the State of Tennessee alone lost in 1874 as much as $500,000. This southern Buffalo-gnat occurs as far north as Minneapolis, at least a few specimens have been found there. Here in Minnesota we have a number of other species of this family of flies, which cause more or less injury to our stock. A few of them are illustrated in figs. 143 to 151. The first species seen and felt occurs very early in spring, soon after the snow has disappeared. It is a very small species, which flies with great force so that it can be felt when striking the face. It seems that it does not care much for human blood, but it irritates considerably by being of a very inquisitive nature, even entering mouth, nose, ear and what is worse, the eye. If horses are left standing for some time in the roads, they are apt to become restive, shake their heads in a violent manner, frequently stamping and snorting at the same time. If the ears of the horse are inspected we usually find the cause of their irritation in a large number of such small flies, which are busily engaged in sucking the blood, and they do so by inserting their powerful piercing organs into a vein, hence they seem to be arranged in regular rows. If not occurring in very large numbers they cause but little harm, and an application of a little grease rubbed together with a few drops of carbolic acid, soon remedies the evil, and drives away other intruders. According to Coquillett, who kindly determined a number of species of this genus for the writer, it is an undescribed species. On account of its very small size the name of *Simulium minutum* is proposed. The female insect is illustrated in fig. 145; the male has not been seen. This species flies from May 15 to

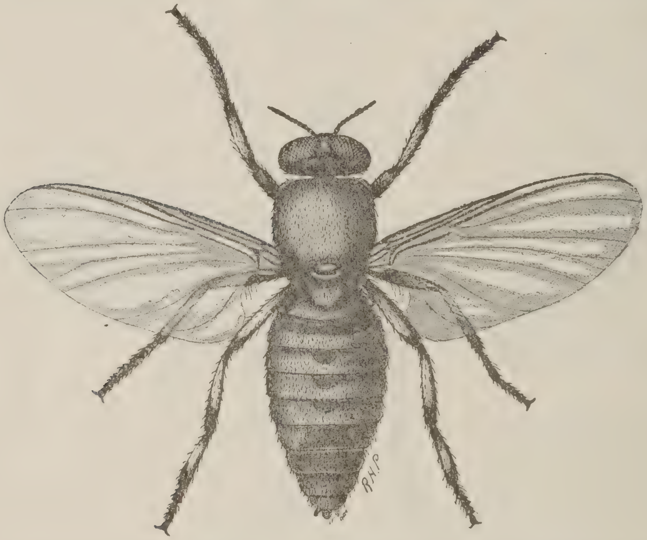

Fig. 144.—*Simulium decorum.* Female. Greatly enlarged. Original.

June 1, and very likely breeds in the Mississippi river near Minneapolis, though the earlier stages have, as yet, not been found.

A little later in the season, but chiefly during June and July, a somewhat larger species (*Simulium decorum* Walk.) becomes numerous. A female is shown in fig. 144. This species occurs sometimes in large numbers, but only females have been found thus far. This is of course easily explained by the fact that only the females of these flies are bloodthirsty; the males remain near the place of their birth, some running water, and as they have only a rudimentary mouth they could not imbibe blood, even if they were inclined to do so. This fly attacks, by preference, cows, and is sometimes found in such large numbers as to cause some injury to them. They are found most usually in the ears, and between the legs, or wherever the skin of the animal is thin and not well covered with hairs. Sometimes the cows suffer severely from their attacks, and being constantly irritated by these small tormenters they lose in flesh and give less milk. As seen in the illustration this fly is rather prettily marked. The front feet are in constant motion, a habit all species have, and are utilized more as feelers than as legs.

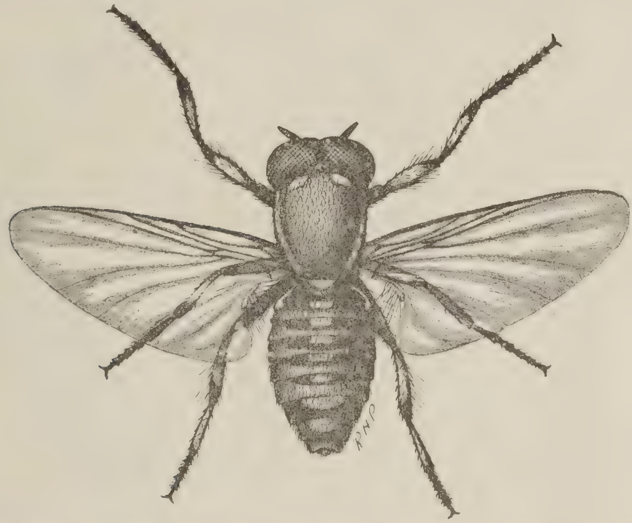

Fig. 145.—*Simulium irritatum*, n. s. Male. Greatly enlarged. Original.

This species is found active during the whole summer and autumn, but only in certain places, which can, however, be very far from the breeding-places, and these insects must possess some very powerful senses to detect their victims such long distances.

In our lake regions we find a large number of streams that flow over rocky bottoms and are obstructed by floating grasses, and other submerged plants. When we see a place in which the water flows more rapidly than in others, we can be certain to find there the early stages of buffalo-gnats. By investigating the plants that cause an obstruction, we find large numbers of larvæ and pupæ fastened to them. In the more central part of the state we find the adults, illustrated in figs. 143 to 146, (the former showing a male, the latter a female) the most common species, while in the northern rivers the species illustrated in figs. 147 to 151 is

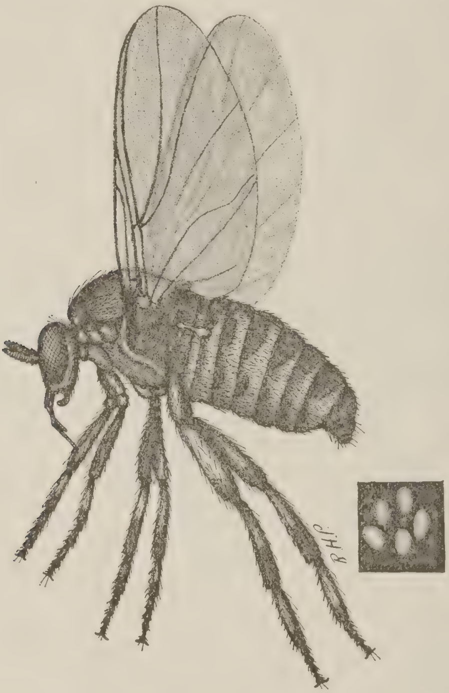

Fig. 146.—*Simulium irritatum*, n. s. Female and eggs. Greatly enlarged. Original.

the common one. This latter species is a great tormenter to humanity, and the proverbial patience of fishermen is severely taxed by their bites. In the northern part of Minnesota this species is called the "black-fly." Their bite is very severe, and the experience narrated by A. S. Packard would apply to this insect as well as to the one that tormented him in Labrador. In many places fishermen have to build smudges to drive away some of these tormenters. As both these kinds seem to be undescribed, the name *S. irritatum* is proposed for the first and *S. tribulatum* for the second species.

All these insects have a very similar life-history, and the one given will apply to all. Their peculiar larvæ (fig. 147) live in swift currents of creeks and rivers, where they feed upon small aquatic animals. To obtain this food they are equipped with peculiar fans on their heads, which are constantly moving in the water, thus creating a current towards the mouth proper, and the material thus brought there is sorted by the other mouth-organs and either utilized or repelled. The larvæ living in such a swift current anchor themselves by a peculiar sucking-disk at the end of their body and by a tough silken line, and are thus kept in position, which is an upright one, and one in which the face fronts the current. The larvæ breathe by means of a peculiar organ situated near the tail, and the different species are distinguished by these breathing-organs, which are either very simple as the one shown in fig. 147, or are quite complicated. Only one leg is found upon these strange looking beings, and this is found upon the first joint, yet by means of it and the sucking disk at the tail end the larvæ can move about like the well-known measuring-worms or geometers.

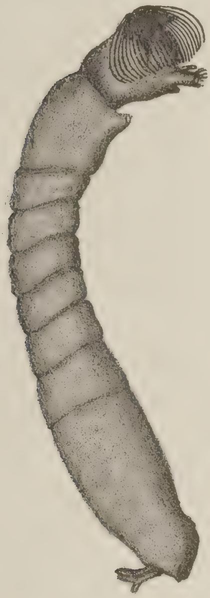

Fig. 147.—*Simulium tribulatum*, n. s.; larva. Greatly enlarged. Original.

Constantly feeding, these larvæ grow very rapidly, and are soon ready to transform into pupæ. But before they can do so they have to construct some protection for the inactive pupæ, otherwise this would be swept away by the current. They construct for this purpose a neat little cradle-like house, made loosely of silk, and open at the top. This cradle, shown in fig. 148, is built against a stone, or upon submerged plants. In it the larva fastens itself by a little loose silk in the closed part, and now transforms to a pupa, as shown in the illustration, and again, removed from the cradle, in fig. 149. But a great change has taken place, and the insect no longer breathes through an organ located near the tail, but by an entirely different one near the head. These breathing-organs differ greatly in the different species, but are always composed of a number of fine thread-like tubes closed at the end, and which unite near the base in a

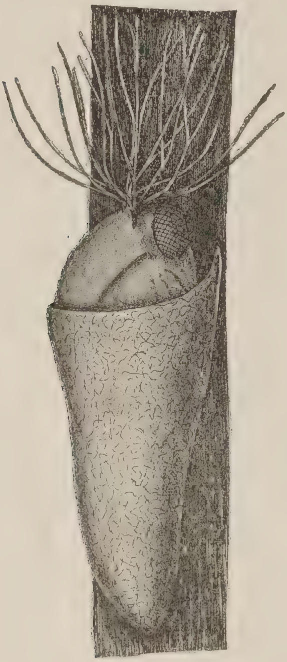

Fig. 148.—*Simulium tribulatum*, cocoon. Greatly enlarged. Original.

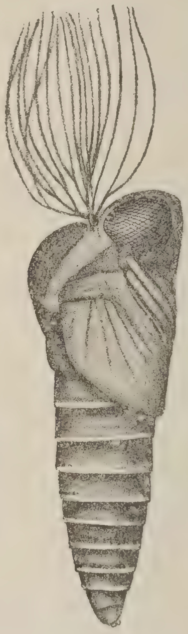

Fig. 149.—*Simulium tribulatum*, pupa. Greatly enlarged. Original.

larger tube that communicates with the interior tracheal system. Gradually the fly forms inside the pupa, and when ready to issue it leaves its old quarters, and popping to the surface like a cork runs over it, and flies off to the shore to harden its chitinous covering. Such larvæ and pupæ abound in all our northern streams, but only in places where there is a swift current. Here the eggs are also deposited, and most frequently upon stones near enough to the surface of the water to be kept moist, or upon the projecting parts of submerged objects. The female is, in fact, able to dive, and can deposit her eggs even under water. These eggs are arranged in a very neat manner, and are usually white, as shown in fig. 146. The adult gnats, that were obtained from the larvæ and pupæ illustrated, are shown in figs. 150 and 151. The male, as can be seen in fig. 151, varies very much from the female, fig. 150, being much smaller and having very large, brilliant red eyes that meet on top of head; the markings are also quite different, the body being velvety black with bright golden-yellow and blue spots; the female is gray with black markings. This species is the most abundant one, usually called in Minnesota the "black-fly" though quite different from the genuine article.

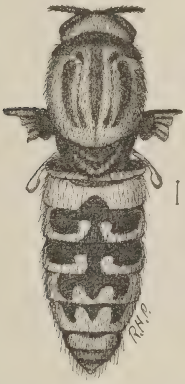

Fig. 150—*Simulium tribulatum.* Female. Greatly enlarged. Original.

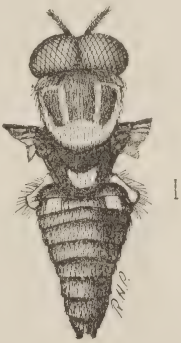

Fig. 151.—*Simulium tribulatum.* Male. Greatly enlarged. Original.

Very little can be done to destroy this insect in its earlier stages. The removal of obstructions in the rivers, which cause an acceleration of the motion of the water, would destroy some of their breeding-places, but when there are so many this would make but little difference. Any chemicals to kill the larvæ and pupæ in the water would also kill fish, as they would have to be used very strong. The only way we have to protect ourselves and our animals are repelling substances, such as stinking-oils and smudges. A number of repellants are sold and some of them are very good, for instance the "Black-fly Cream," made in Portland, Maine. Our fishermen and hunters frequently use a mixture of kerosene-oil and mutton-tallow, with which the exposed parts are greased. For animals any of the strong-smelling oils can be used, but repeated applications are apt to injure them or to remove the hair. Oil of tar is a simple and easily applied wash. To make it, a quantity of coal-tar is placed in a large shallow receptacle in which is stirred a small quantity of oil of tar, or oil of turpentine, or any similar material. After filling the receptacle with water it is kept undisturbed for several days, when the animals to be protected are washed with the impregnated water whenever necessary. Smudges are best as a protection and the animals soon realize their protecting influence and crowd to them for shelter, even refusing to leave them when needed elsewhere. As the black-flies are active only during the day, and the mosquitoes towards evening and night, dwellers in our northern woods have a bad time of it and sometimes suffer very greatly on their account. It is easy, however, to drive these tormenters from houses or tents. By burning inside of them a little pyrethrum powder (Persian or Dalmatian insect-powder) upon a piece of bark these intruders are either killed or become so stupefied that they do not bite for some time. This method is in general use in the houses and stores of the Hudson Bay Company, and the writer has always used it successfully in his numerous trips. The fumes of the burning insect-powder are not very offensive, at least not nearly so much so as the poisonous bites of such insects as black-flies and mosquitoes.

MOSQUITOES.

(*Culicidæ*).

Like the flies belonging to the family of *Simulidæ* just mentioned, they also pass their early stages in water, and also, perhaps, in damp and shady ground. Here the adults are very numerous, though winds may carry them also far from their place of birth. They subsist on vegetable juices,* but if opportunity offers the females attack and suck the blood of all kinds of animals. Members of this family are recognized by their long body, by the fourteen-jointed, filiform and very plumose feelers, especially in the males; by the bulging thorax, by the narrow, cylindrical abdomen and thin legs, elongated narrow wings, lying flat on the body during rest, and by their humming sound during flight. The wings are covered, especially along the veins, with scales, some of which are shown in fig. 154. At least 30 species of these bloodthirsty insects are found in the United States, and some of the names *molestus*, *musicus*, *damnosus*, *excrucians*, *provocans*, *territans* and others they received show that their powers of tormenting man and beast were fully realized by the authors. Dr. A. S. Packard, in his interesting book "Our Common Insects," describes the mosquito and its mouth-parts in the following poetical words: "as she leaps off from her light bark, the cast chrysalis skin of her early life beneath the waters, and sails away in the sun-light, her velvety wings fringed with silken hairs, and her neatly bodiced trim figure (though her nose is rather salient, considering that it is half as long as her entire body), present a beauty and grace of form and movement quite unsurpassed by her dipterous allies. She draws near and softly alights upon the hand of the charmed beholder, subdues her trumpeting notes, folds her wings noiselessly upon her back, daintily sets down one foot after the other, and with an eagerness chastened by the most refined delicacy for the feelings of her victim, and with the air of Velpeau redivivus, drives through crushed and bleeding capillaries, shrinking nerves and injured tissues, a many-bladed lancet of marvellous fineness, of wonderful complexity and fitness. While she is engorging herself with our blood, we will examine under the microscope the mosquito's mouth. The head (fig. 152) is rounded, with the two eyes occupying a large part of the surface, and nearly meeting on the top of the head. Out of the forehead, so to speak, grow the long, delicate, hairy antennæ (*a*), and just below arises the long beak which consists of bristle-like maxillæ (*mx* with their palpi, *mp*) and mandibles (*m*), and the single hair-like labrum, (labrum-epipharynx (*lr-e*) and hypopharynx (*h*), these five bristle-like organs being laid in the hollowed labium (*l*). Thus massed into a single awl-like beak, the mosquito, without any apparent effort, thrusts them all except the labium into the flesh. Her hind body may be seen filling with the red blood, until it cries quits, and the insect withdraws its sting and flies sluggishly away. In a moment the wounded part itches slightly, though a very

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* When sugaring for moths, a method often employed by entomologists to collect large numbers of owlet-moths, the bait is frequently covered with mosquitoes, all busily engaged in sucking this sweet material.

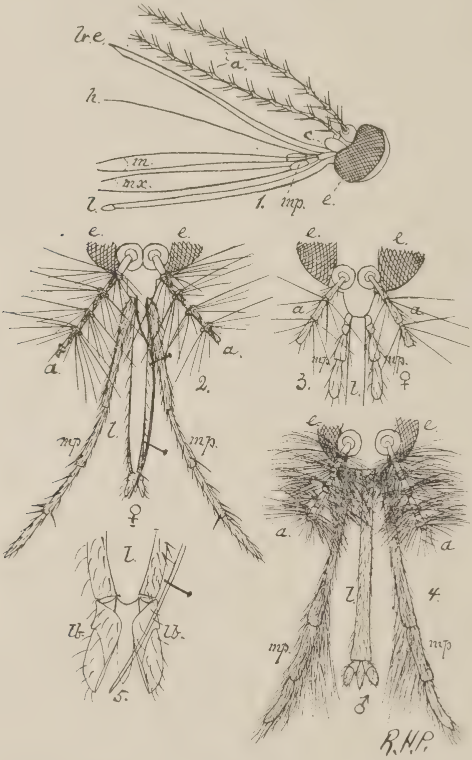


Fig. 152.—Head of mosquito (several species, males and females); *a*, antennæ; *mx*, maxillæ; *mp*, maxillary palpi; *m*, mandibles; *lr-e*, labrum-epipharynx; *h*, hypopharynx; *l*, labium. Greatly enlarged. Original.

robust person may not notice the irritation, or a more delicate person if asleep; though if weakened by disease, or if stung in a highly vascular and sensitive part, such as the eyelid, the bite becomes really a serious matter. Multiply the mosquito a thousand fold, and one flees their attacks and avoids their haunts as he would a nest of hornets."

It is perhaps not necessary to introduce this insect, as most persons claim a very intimate acquaintance with the female mosquito, while they hardly know her more retiring husband, who is also more beautiful, both physically and morally. There are, however, many peculiar traits in the history of this aggressive insect, which but few persons are aware of, and at the risk of repeating well-known facts, the essential points of its life-history will be given. A glance at the illustration (fig. 153) will make some of them quite plain.

Early this spring, 1896, when all plant-life was in the bonds of winter, no insects could be discovered by those whose eyes were not trained for seeing such things. Yet a close and trained observer could readily discover in sheltered nooks and corners, in cellars and stables, under loose boards and under stones, a large number of insects that had found winter quarters in such places. Besides a number of different flies and other insects detected in cellars, a few mosquitoes could be seen which were pale and by no means such active beings as they are later in the season. The last snow, which fell towards the end of April, brought with it immense numbers of mosquitoes of a large size and of a pale-brown color (*Culex consobrinus*). The writer counted as many as four to twenty-one mosquitoes upon a square yard of level surface. In northern latitudes it is not uncommon to find mosquitoes even in mid-winter, and thousands appear as soon as the sun comes out warm. Many years ago the writer saw in February a very large swarm of mosquitoes in Detroit, Mich.; they were very annoying for some weeks, when their numbers gradually became less. Whence did they come? To treat these emigrants in a hospitable manner, an old barrel was cut in two and filled with rain-water, to attract and give them a home for their offspring. Of course such hospitality should not in such a case become a general practice, as these insects are apt to take an unfair advantage of their host. The mosquitoes were not slow to utilize these artificial ponds and in a manner that will be shown later. At the same time large numbers of both sexes of these mosquitoes congregated upon the windows, and many entered the houses, as if to indicate to the inhabitants that mosquito-screens would soon be of some use. The great majority of mosquitoes entering houses were females, and but very few males could be detected. Early in May, and throughout the summer, numerous generations of mosquitoes were produced in these barrels and in all stagnant water that

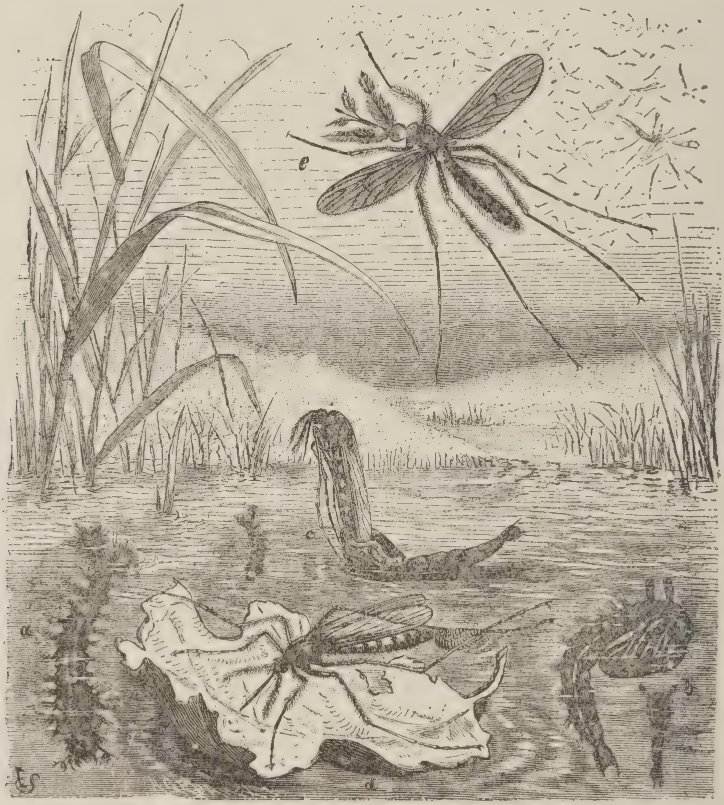


Fig. 153.—Mosquitoes at home; *a*, larva; *b*, pupa; *c*, adult leaving pupal skin; *d*, female depositing egg; *e*, male. Greatly enlarged. After Brehm.

possessed certain properties. The water had to be rain-water full of animal or vegetable matter, and had to be located in a depression so that the wind could not disturb its surface very greatly. Ponds were also utilized, providing plenty of grass and other plants formed an obstruction to retard or prevent the waves from disturbing the surface in too violent a manner. In the middle or in the deeper part of ponds but few larvæ or pupæ of mosquitoes could be found. With the arrival of warmer weather those mosquitoes, that had found a shelter in which to hibernate, also started into renewed activity, and they also commenced to multiply in a very rapid manner.

After a short season of love the female mosquito deposited her eggs upon the surface of the water, and selected for this purpose almost invariably the very early morning, so that it was somewhat troublesome to watch this operation, especially, as all other female mosquitoes not engaged in such work would try their very best to drive away the intruder. They did this not in a very ladylike manner and their remarks about the intruder were of a most biting character! Of course the gentlemanly male did not engage in biting, simply because he can not do so, lacking the necessary organs for that purpose. Selecting a floating object or a quiet spot where the water is not greatly disturbed, the female deposits a large number of eggs in the shape of a raft. In doing so the female supports her body upon the four front legs, while her two hind legs are crossed, as seen in the illustration (153 *d*). In this angle thus formed by the hind legs, the eggs are formed into a sort of raft as they pass one by one from the abdomen, and being sticky they adhere to each other. These small egg-masses look like a bit of floating soot, and if investigated more closely it will be found that each contains on an average over 300 eggs, and that each egg is a very elongated affair, resembling an old-styled flask with a stopper. Such egg-masses, which must float upon the surface of the water to obtain the necessary air and warmth, will always float in the proper position, no matter how violently we may stir the water. To enable them to do so a film of air surrounds the eggs, thus also preventing a direct contact with the water; yet this film disappears from the exposed surface of the eggs by evaporation as soon as the raft is in a proper position. In three to five days these eggs hatch and produce from the lower ends the well-known "wigglers," so commonly seen in rain barrels and watering troughs. This common name is well-deserved by the wiggling motion of the larvæ. These feed mainly below the surface of the water, and move just below it, as if it were a solid substance. This is a very queer thing, as the specific weight of these larvæ is greater than that of the water in which they move. If they move away from this surface film of water, they invariably sink to the bottom, at least they do if not using their swimming plates at the ends of their tails. The larger and stronger larvæ feed near the bottom of the water upon decaying vegetable matter, and only rise to the surface to obtain air. Such a larva (*a*) has a large head and thorax, while its abdomen is much more slender. Its head, which usually points downward, possesses vibratile organs for sweeping minute particles of food into the mouth. In this shape the larvæ have to breathe air, but being surrounded by water this would be very difficult if they did not possess a cylindrical siphon or breathing-tube at the end of the last segment. The tail-like breathing-tube is pushed above the water, and the necessary supply of air is thus secured. As this does not last very long the larvæ are forced to repeat this operation quite frequently. The larval stage lasts but a very short time in some species of mosquitoes, while in others it extends over a much longer period. This depends to some extent upon the season. The writer kept larvæ which changed in five days to pupæ; other larvæ of a different species of mosquito require almost three weeks to reach their full size. During this period the latter ones moulted three times. When full grown a very remarkable change takes place, and a club-shaped pupa with greatly enlarged head and thorax, is now seen (*b*). The strange part of this wonderful change is the possession of two slender breathing-tubes upon the back of the thorax instead of a single one in front of the tail. Though the pupa does not require any food it must be able to save itself when disturbed and it does so the very moment the surface of the water becomes agitated, by a few strokes with paddle-like swimming-organs located at the tail. The trumpet-shaped breathing-tubes contain upon their inner surface a large number of peculiar hairs, which prevent the water from entering. Like the larva the pupa has to come frequently to the surface to breathe air, and if not disturbed always hangs suspended from the surface-film of the water. In a few days the last transformation takes place, which is well shown in (*c*). The pupal skin splits open in the back, thus forming a boat, and the adult and winged mosquito works its way very carefully out of the many fine skins that enclose its various members. As soon as the wings are expanded and dry the insect flies away, now breathing air in the usual manner of insects by means of fine openings located in the sides of the thorax and abdomen. We have here the interesting fact that the same insect has to breathe air in three different ways and by three different sets of organs, each seen to be most wonderful in structure if carefully studied by means of a microscope.

Thus far both sexes were very similar in structure, but if we now study them in their winged shape we shall find them quite different. The male (*e*) is distinguished by very large and feather-like feelers, and by rudimentary mouth-parts. The female (*d* and *c*) has smaller feelers, and a hard, long and slender proboscis, decidedly well adapted to sucking blood. Of course in nature but few of these bloodthirsty females ever have an opportunity to obtain such food, and they must subsist upon something else. It is suspected, and the experiments made this summer but not yet finished seem to prove it, that females inbibing such blood die in consequence. Where is the benefit to the species if such is the case?

Regions in which stagnant water abounds are famous, or rather infamous, on account of the vast number of such insects, and their presence is easily accounted for. But we find them many miles away from water and sometimes in equally large numbers. Where do they come from and where do they breed?

There are many other very interesting points in the life-history of this insect. But what earthly good is it to study all these details? Where is the benefit to farmers? As a reply it might be stated that by knowing all these details it is easy to reduce the numbers of these insects very materially near our houses; at least this can be done in many cases. Knowing that the eggs are laid upon the water, that larvæ and pupæ have to live in it and have to come to the surface to breathe air, we have an excellent way of killing vast numbers. During the summer the writer has kept a sort of census of the number of mosquitoes raised in rain-water in two barrels, and two counts will be given to show how many mosquitoes can be raised near the farm-house, or where they are most needed! July 6th, 1896, the water in one barrel was filtered. It contained 35 grams of mosquitoes, each gram, by count, numbering 217, hence 35x217=7,595 larvæ and pupæ. Besides this 32 egg-masses, each containing on an average 302 eggs, were found, which would hatch

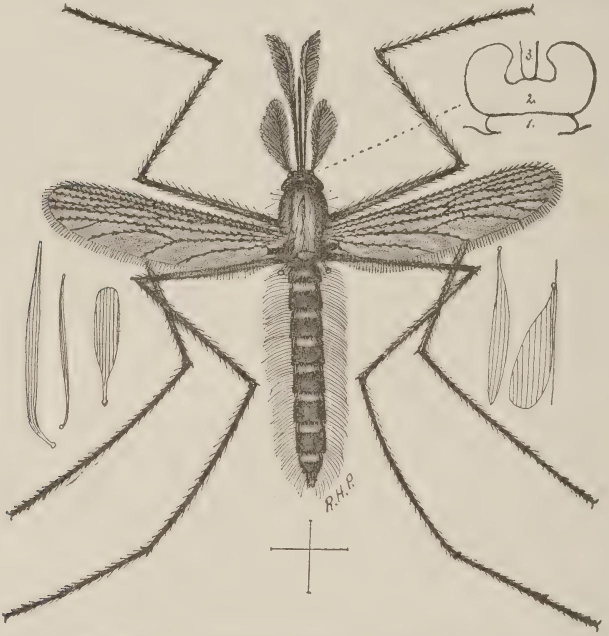


Fig. 154.—Mosquito, male; showing also scales and section through ear. Greatly enlarged. Original.

into 302x32=9,664 mosquitoes. Total number of eggs, larvæ and pupæ, 17,259. July 22d, 1896, by a similar process, 19,110 mosquitoes were counted. At the present time (Sept.) not so many eggs are deposited, but there are still immense numbers of immature insects in pools and ditches and other suitable breeding-places.

It is assuredly not a good thing to breed mosquitoes near our houses. To prevent them from doing so all that is necessary is to shut them off from a supply of air and there is an exceedingly simple and cheap way of doing it most effectually. Many trials have shown that by pouring just one or two spoonfuls of kerosene-oil upon the water in rain-barrels, and by stirring the water so that the surface is equally covered with a film of oil, all eggs, larvæ, and pupæ die by suffocation within five minutes. This is surely a simple way of killing multitudes of such insects, and as the oil will evaporate very soon, the water is by no means spoiled. If done very early in the season, and repeated every four-

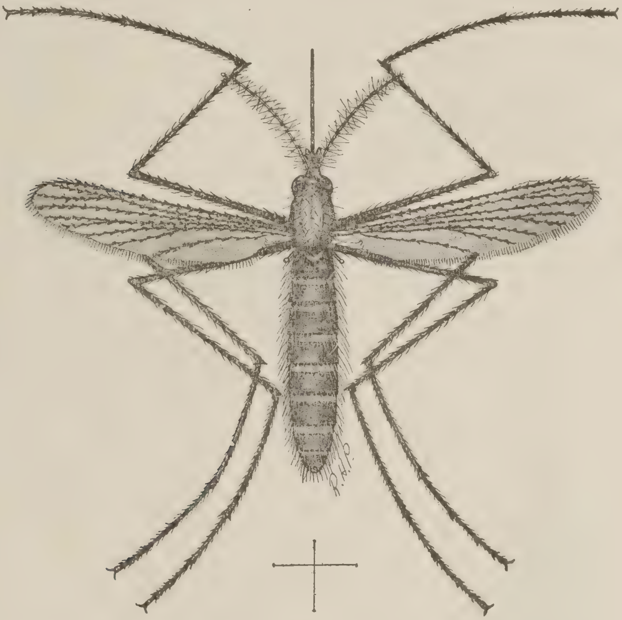


Fig. 155.—Mosquito, female. Greatly enlarged. Original.

teen days, no mosquitoes will breed in this water so important upon prairie farms. Small bodies of water in pools, ditches and ponds should be treated in a similar manner, especially early in the season, when the surface is still free from projecting plants. A few gallons, or even quarts, thrown upon the surface of the water when the wind is blowing fairly strong, will distribute the oil uniformly over the whole surface of the pond, and thus kill all the mosquitoes. Like most remedies against noxious insects this one should be used in time, or before the enemy has become very numerous. These aggressive insects can be kept away from houses, barns and cattle in the field by a smudge, or by strong-smelling substances, and in regions where they occur in vast numbers, such smudges are built in the evenings. Sportsmen anoint their faces and hands with various compounds composed of mutton tallow and oil of pennyroyal, or of oil of tar. The following mixture is excellent for this purpose:

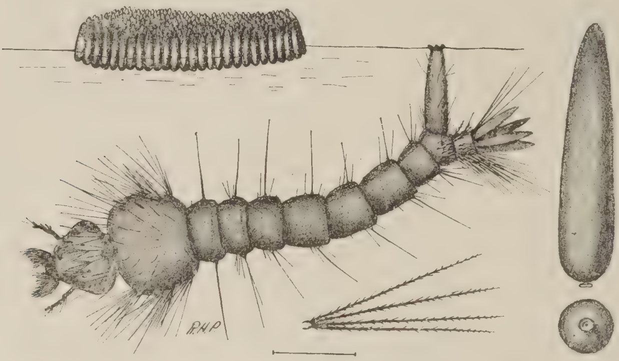


Fig. 156.—Mosquito, larva and eggs; also a single egg. Greatly enlarged. Original.

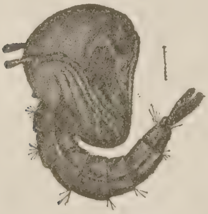


Fig. 157.—Mosquito, pupa. Greatly enlarged. Original.

Olive oil, 3 parts; oil of pennyroyal, 2 parts; glycerine, 1 part; ammonia, 1 part.

A wash with ammonia usually removes all bad effects of their bites, at least in most persons. The poison injected by these tormenters acts very differently upon different persons; in some it causes large swellings, in others fever and pains in limbs, and in extreme cases even insanity, while others are but little annoyed.

We have a large number of species in our state and in certain years and localities they make such places almost uninhabitable for man. Prof. Riley remarks in "Little Known Facts about Well Known Animals," that "they have caused the rout of armies and the desertion of cities, and the hum of an insignificant gnat may inspire more terror than the roar of the lion." (Historical data are not given.) "The bravest man on the fleetest horse dare not cross some of the more rank and dark prairies of Northern Minnesota in June. It is well known that Father De Smith once nearly died from mosquito bites, his flesh being so swollen around the arms and legs that it literally burst. Those who have traveled in summer on the lower Mississippi or in the North-west, have experienced the torment which

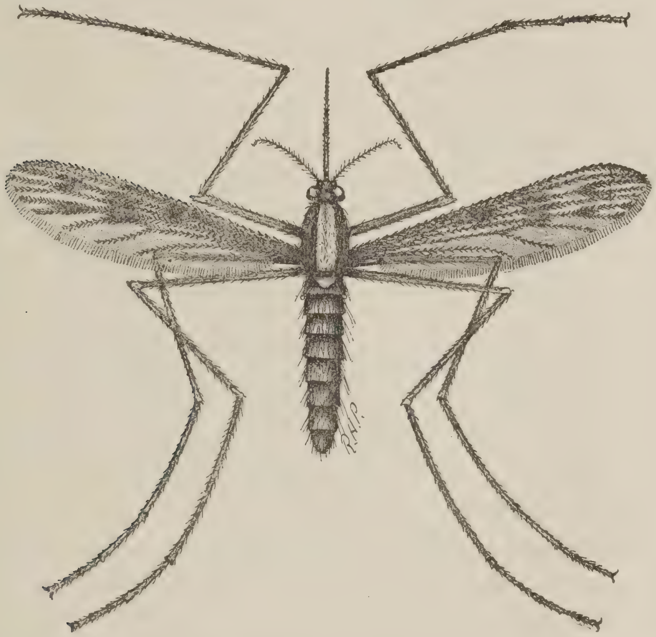


Fig. 158.—*Anopheles quadrimaculatus* Say. Greatly enlarged. Original.

these frail flies can inflict; at times they drive everyone from the boat, and trains can sometimes only run with comfort on the Northern Pacific by keeping a smudge in the baggage car and the doors of all the coaches open to the fumes."

Prof. Riley wrote the above lines many years ago, and conditions have greatly changed since. The mosquito is still a great pest in some places in Minnesota, sometimes even killing animals that can not escape it, but the prairies are rapidly settled in spite of them, and as the land is gradually better drained mosquitoes become fewer and fewer. They are very abundant north. In Davis's straits, in lat. 72° N., Dr. Bessels, on board the Polaris, was obliged to interrupt his observations on account of the multitudes of these insects. A great number were also seen up to the 81st. deg. of latitude. An old writer, writing about the northern shores of Lake Superior, expresses himself in this way: "When the mosquitoes disappeared the black-flies came; the mosquito pumps up a drop of blood and flies away, the black-fly bites and makes a wound which continues to bleed."

In tropical America these insects are still worse, and they are the source of such incessant torments that some of the most beautiful regions of the globe are unfit for a white population. In the llanos and prairies of Venezuela they persecute cattle to such an extent that they do not thrive even on the richest pastures.

Of the many species found in our state a few have been studied more in detail, as well as their life-history. The illustrations (figs. 154, 155, 156 and 157) show a common species (*Culex pungens* Wied.); it is the first seen in the spring and the last to disappear late in autumn. Fig. 154 shows the male, and some of the peculiar scales found upon the veins of the wings; the first three joints of one of the feelers is greatly enlarged, to show the auditory organ (Johnson's organ). Fig. 155 shows the female, fig. 156 the full-grown larva, a bunch of hairs from the tail, an egg mass and the enlarged egg; fig. 157 shows the pupa. The color of both male and female is dark gray with lighter yellowish-white bands.

Another species belonging to a different genus, is illustrated in fig. 158; it is less common, and readily recognized by the spotted appearance of the wings; it is *Anapheles quadrimaculatus* Say.

There are a large number of other species of flies which occasionally torment man and his four-footed servants, but it would take too much space to give their history and illustrate their forms. Flies, small and insignificant as they seem, can oppose a stronger barrier to man's explorations than lofty mountains or swift streams.

L. BUGS

(*Hemiptera*).

Bugs or Half-wing insects, have received the latter name by being characterized by having the basal half of the front-wings leathery, while the apical half is thin and membranaceous. Below these upper wings is a pair of larger and thin wings, which are mainly used for flight. The wings, at rest, are crossed flatly over the back. In this order of insects it is not alone the adult or winged insect and its larva that takes food, but the pupa is equally active and hungry. The beak is a horny, pointed, tapering, three- or four-jointed tube (labium), which is inserted beneath the front of the head. Four stiff bristles (mandibles and maxillæ) are enclosed in this tube, and these are adapted for piercing vegetable or animal tissues. The setaceous maxillæ and mandibles, the latter armed with recurved teeth, are inserted, and a drop of poison is injected at the same time, which accounts for the inflammation caused by the bites of such insects. Bugs sucking the juice of plants possess usually a long and slender beak; those sucking blood have a curved, short and thick one. The former can become very destructive, as for instance, the well-known chinch-bug, mentioned elsewhere in this report. There are also a large number of true bugs that will attack warm-blooded animals if opportunity offers, yet but very few make it their business to do so constantly, and these have in the course of time become veritable blood-sucking parasites.

THE BED-BUG.

(*Acanthia lectularia* Linn.).

Some persons claim that they have never seen these parasites; this means that they have either been very fortunate, or that they did not use their eyes or their nose, as bed-bugs are found wherever man has made a home for himself. It is a mooted point whence they came originally, but this, although interesting, makes but little difference at present, as they are now everywhere.

The illustration (fig. 159) shows how this nasty insect looks. We see that, being a parasite, and no longer leading a rambling existence like other bugs, but being a sort of domesticated animal, it has lost the wings, these being no longer required, and it possesses simply rudiments of them. These are indicated in the illustration, and look like a little chitinous flap on each side of the thorax. The adult bugs, as well as the younger ones, are well adapted to enter narrow cracks, having a very flattened shape, and in such shelters they hide during the day, being active only at night. They deposit during spring about fifty white and oval eggs, 1.12mm. long, and similar to those shown in fig. 161, in the

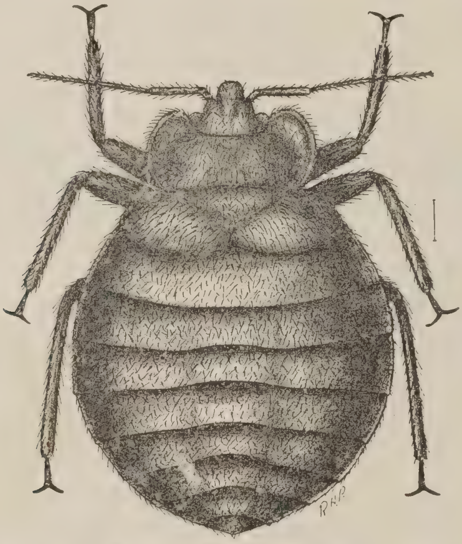


Fig. 159.—Bed-bug. Greatly enlarged. Original.

joints of bed-steads, cracks in walls, under loose wall-paper, but especially near iron, be this an old nail in the wall or the hooks that are used to fasten the bedstead together. These eggs are very beautiful objects; they are terminated by a cap, which is removed by the escaping young bugs. These latter possess the color of innocence, being white and almost transparent; they look, in shape, very much like the old ones, and are only a little broader in comparison, and have stouter feelers. As soon as they can attack a victim they become round and resemble a minute globule of blood. Imbibing blood whenever they have an opportunity they quickly grow, and after moulting several times they reach their adult and sexually mature condition. The organ by means of which they obtain blood, is a sucking-tube or haustellum. (Fig. 160.) This is composed of two half cylindrical side-pieces, analogous with the labium and labial-palpi, and enclosed in this tube are four sharp and pointed lancets, the transformed mandibles and maxillary palpi.

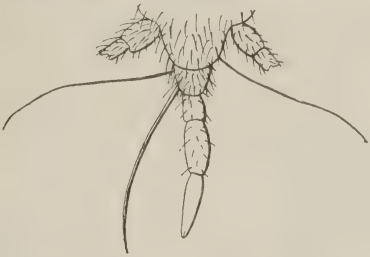


Fig. 160.—Mouth-part of bed-bug. Greatly enlarged. Original.

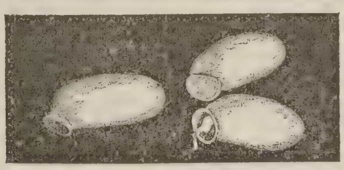


Fig. 161.—Eggs of bed-bugs found in swallow-nest. Greatly enlarged. Original.

The female deposits eggs during the warmer season four times, and about fifty at a time. In Minnesota these bugs have only one annual generation, yet judging from their numbers in certain, not first-class, hotels not hundreds of miles distant from the "twin cities," they should have numerous broods every few weeks. With plenty of food and a warm temperature, they multiply rapidly; and if things are favorable it requires only eleven weeks for the bug to undergo its transformation from egg to adult. Only the adult insects hibernate or are able to withstand severe cold. It is not necessary to describe this insect in detail, as the illustration shows well the structure of this yellowish-brown parasite. The disagreeable "bed-buggy" odor is produced in minute glands which are situated in the adult bug on the under side of the body, and in the young one on the back of the thorax. The peculiar and penetrating odor of these parasites is, to many persons, even worse than their bites. Those who have been forced to sleep in a room which had not been occupied for weeks, and in a bed alive with hungry bed-bugs, know how interesting these parasites can make it, and how active they become as soon as the light is extinguished. Like harpies they attack the would-be sleeper and their bites produce the sensation of being stung with hot needles; soon the whole body is in a fever, and big swellings appear wherever a bug has inserted his beak. If a light is suddenly ignited, the bugs run away as quickly as they can to their hiding-places. A glance at the ceiling of the occupied rooms will reveal many bugs, which have crawled there with the intention of dropping down upon the sleeper. Though always hungry and ready to imbibe blood bed-bugs can also exist for a long time, even for a year, without any food. Prof. Leunis kept a female bed-bug in an empty paper-box for six months; when the box was opened not only the living female was found, but she was surrounded by numerous young bugs, which, like the mother, were white and transparent as glass.

We have a large number of remedies against this insect. Cleanliness is, of course, the best preventive. Yet with all care bed-bugs can and will enter houses, because they are so readily carried with trunks, etc. from infested places, and if they once find a home they are, on account of their form, which is well adapted for hiding, and their capacity for fasting, not readily driven away. The free use of benzine, or of kerosene, sprayed with a hand-atomizer into all suspected cracks, will kill all insects including the eggs, with which it actually comes in contact. This spraying has to be repeated from time to time, and if carefully and thoroughly done the bed-bugs have no chance to exist in such beds or rooms. If we paint the cracks in a bed-stead or the wall, the ends of the slats, and all other suspected places, with one ounce corrosive sublimate dissolved in a half-pint of alcohol and one-fourth pint of oil of turpentine, we have an excellent remedy.

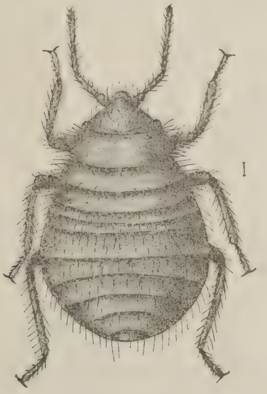


Fig. 162.—Larva of bed-bug found in nest of swallow. Greatly enlarged. Original.

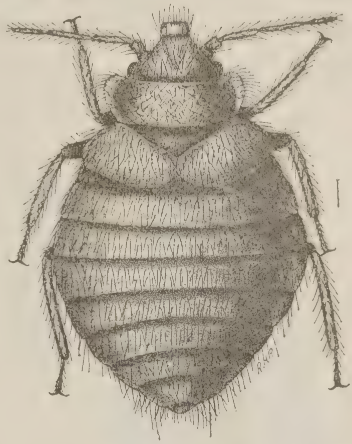


Fig. 163.—Adult of bed-bug found in nest of swallow. Greatly enlarged. Original.

All remedies are best applied in early spring, so as to kill all the old hibernating females before they have deposited eggs.

While traveling, it is well to remember that bed-bugs are only active during the night and that they abhor light. So if forced to sleep in a bed suspected of containing such unwelcome inhabitants it is wise to permit the lamp to burn all night.

Bugs, very similar to bed-bugs, attack chickens, pigeons, swallows and bats. Those found in the nests of swallows not infrequently reach the inside of houses against which these beneficial birds have built their clay-nests. Such bugs (fig. 161, 162, 163) resemble very closely the genuine bed-bug, yet are quite different when studied in detail; they are much smaller, darker, and can not exist for any length of time away from their proper home, the nest of the swallow, where they are sometimes exceedingly numerous. The illustration shows the eggs, young and adult, of this species (*Acanthia hirundinis* Senyns).

It is frequently stated that bed-bugs occur in our pinewoods in a wild condition under bark, etc., and that whenever a log-cabin is erected this would immediately swarm with bed-bugs. Truth and fiction are here sadly mixed! It is truth that such cabins often contain a dense population of various insects parasitic upon man, but they have been brought there by the inhabitants, and did not come with the timber from the woods. In many cases, when the writer asked for the proofs, such insects as are shown in figs. 164 and 165 were sent to him as examples of them. They resemble bed-bugs in many ways, especially in their earlier and unwinged stages, but a trained eye can readily detect the very great difference between the two. Two species are most commonly found in and about log-cabins; the one illustrated (fig. 164, adult; and fig. 165, larva) is black, as flat as the genuine bed-bug, and just as inactive during the day. It is a species of *Aradus*. Another species not illustrated, resembles the bed-bug even more closely, being of the same color and size; this is *Aradus cinnamomeus*. These insects,

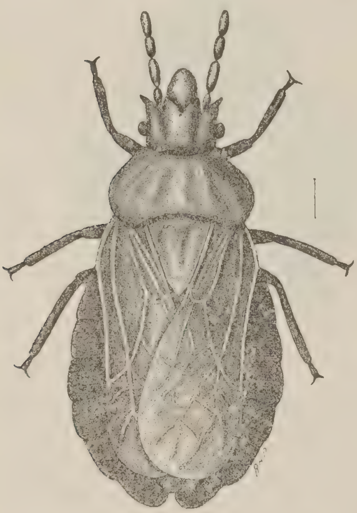


Fig. 164.—Adult of *Aradus* spec. Greatly enlarged. Original.

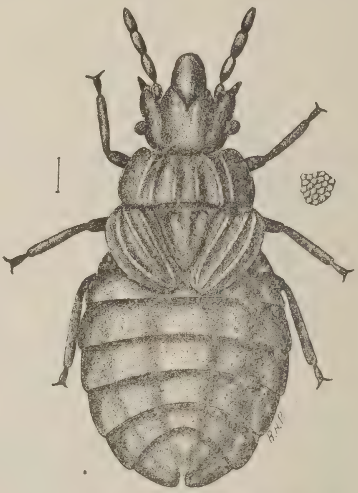


Fig. 165.—Larva of *Aradus* spec. Greatly enlarged. Original.

as well as a number of similar ones, live normally under bark of dead and living trees; they are true vegetable feeders, subsisting upon the sap of plants. Whenever logs are cut the sap contained in them and especially that near the surface, ferments, and this attracts a large number of insects fond of such fluid. This explains why so many insects can be found near saw-mills, and chiefly upon freshly cut boards.

Notwithstanding the bad odor of the bed-bugs they have a number of enemies that are said to destroy them. Prof. C. Vogt writes that the inhabitants of Switzerland claim that fleas and bugs were living in a state of war, and that the fleas had to leave dwellings occupied by bed-bugs, which would indicate that fleas are very sensible insects. Prof. Riley says that little red ants, if invading a house infested with bed-bugs, make short work of the latter, and tear them to pieces wherever found. This may be a consolation, but these ants are far from being good tenants in our dwelling places.

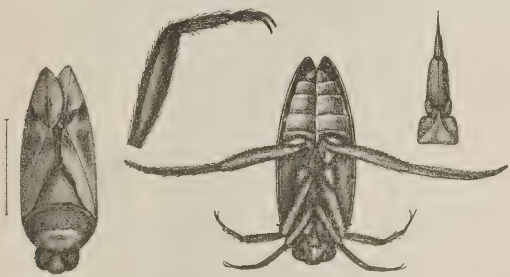


Fig. 166.—Water-boatman. Greatly enlarged. Original.

A number of blood-thirsty bugs are known that make it their aim in life to destroy bed-bugs. This would be an excellent trait in the character of any bug, but these are otherwise so stupid as to treat man and bed-bugs in the same way by biting both, and as the bite of the Pirate-bug (this is the name of the bed-bug destroying kind) is very poisonous and painful, their presence in our houses is not desirable. In the southern states several bugs, such as the Two-spotted Corsair and the Blood-sucking Cone-nose or Big Bed-bug, enter houses for the same laudable purpose but both kinds make the same lamentable mistake and inflict the most painful bites which may disable a weak person for many days.

As already mentioned, other true bugs sometimes bite man and animal, but they do not habitually do so. We can not, therefore, call them genuine parasites. Yet a few come very near to deserving such an appellation, for instance the bug illustrated in fig. 166. This is an aquatic insect and usually called a *Water Boatman* (*Notonecta undulata* Say). This is a well-chosen name! When we observe these insects in their homes we find them floating upon their backs, the long hind legs, admirably adapted for swimming, are spread apart, as if waiting for the command: pull away. These white and black bugs have an oval form, and are deeper-bodied than most other insects, having the convexity of the surface above. They possess large eyes, and a very powerful, four-jointed, elongated beak, which is conical and very acute, as shown in the illustration at the left. Their bite is very poisonous, and it is a fortunate thing for bathers that they do not attack man unless provoked to do so. They will not permit any familiarity and bite whenever roughly handled. Ponds that are drying up, or where all the inhabitants are crowded into a small space, are good places not to bathe in, as the writer can testify.

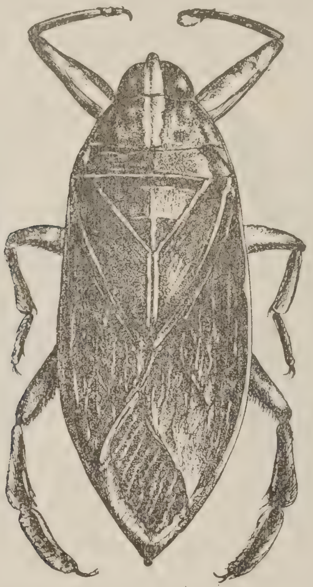


Fig. 167.—Electric-light bug. Slightly enlarged.

The "*Electric-light Bug*" or *The Giant Water-bug* (*Benacus griseus* Say, fig. 167) is a well-known bug that can inflict very severe bites and in handling them the proper precaution should be taken to hold the insect in such a way that it can not use its short beak. Their bite is very poisonous, and whenever they bite a fish this almost immediately dies.

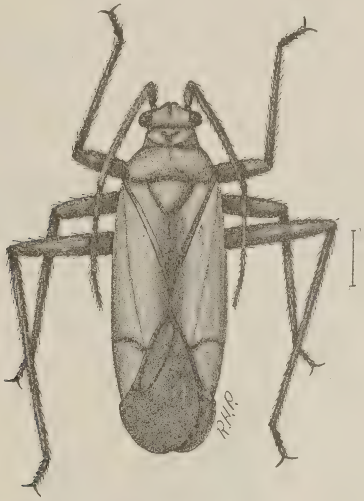


Fig. 168.—*Lopidea media* Say. Greatly enlarged. Original.

Unexpected things are apt to occur, and insects that are usually found only upon plants may develope a taste for blood. While camping for a few days upon an island largely covered with wild gooseberries, the insect illustrated in fig. 168 was frequently observed upon these plants, where it seemed to feed, like all its near relatives, upon the sap. But soon after, the persons living in the camp were bitten very frequently by these bugs, and their bite caused considerable pain and swellings of the bitten part. The bugs would imbibe blood until barely able to fly. But as if to prove their love for human blood they even invaded the tent, and large numbers of them were killed to prevent them from biting. The insect (*Lopidæ media* Say) is a rather brightly-colored bug, being yellowish-red marked with black.

M. OTHER INSECTS.

We find in all orders of insects some species that occasionally attack man and animals and that may injure either by their bite or by their poison. None of them can, however, be called true parasites.

Among the butterflies and moths we have a few whose larvæ cause great pain if they are handled with the bare hands. This pain is caused by peculiarly-shaped, branched spines, which contain poison, or by very fine hairs possessing similar properties.

Among the beetles we have such poisonous insects as the blister-beetles or Spanish-flies; they are utilized as vesicants, hence can be useful in the hands of a physician. There is, however, one small beetle) *Læmophlæus fasciatus*, Melsch.), that deserves more than a passing notice; it is illustrated in fig. 169. This small and flat insect, of a light-brown color, highly polished surface, with a light space upon each wing-cover, is very abundant near saw-mills, especially near those in which hard wood is sawed. In running over the persons engaged in mill work they become not simply annoying, but as they bite often and without any provocation, they become a great nuisance, and the writer has seen very bad sores caused by them. They seem to prefer the neck of their victims, and notwithstanding their small size, as indicated by the line in the illustration, their bite is a painful one.

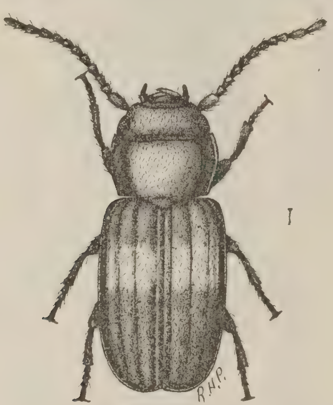


Fig. 169.—*Læmophlæus fasciatus*, Melsch. Greatly enlarged. Original.

Among the bees, wasps, etc., we find a large number of insects that can inflict a very severe sting. But as a very general rule they sting only when provoked, in self-defense, or if they fear for their young. None can therefore be called true parasites of man. Yet ants, at the time when they swarm and cover everything with their active bodies, are not infrequently called parasites. The ant shown in fig. 170

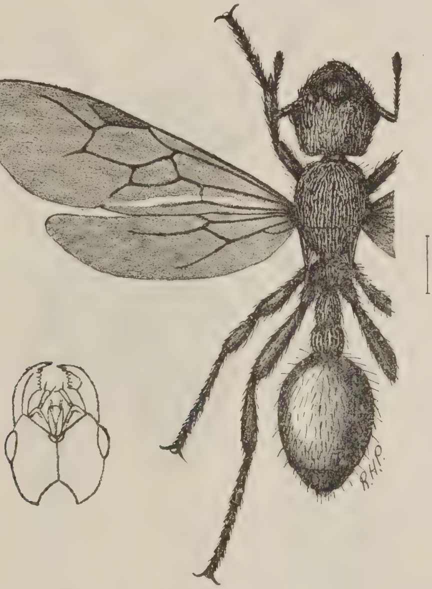


Fig. 170.—Winged ant, *Myrmica scabrinodis* Nyl. Greatly enlarged. Original.

(*Myrmica scabrinodis* Nyl.) was captured during September in an open street-car. Passing through a swarm of these ants the car was taken by storm, and in a very few minutes all the legitimate passengers were stamping, shaking and investigating their clothes. And not in vain, as the perplexed looks of the ladies and of some of the gentlemen clearly showed. If one of the ants was roughly handled in putting it off the car it was not slow to retaliate, and a bite with the formidable jaws shown in the illustration, and a poisonous sting, soon convinced everyone in that car that a more tender handling of these intruders was the better and safer method of dislodging them.

As it is not an uncommon occurrence that persons are bitten or stung by insects, it is well to know what will allay the pain. Generally speaking all the poison injected by insects into wounds, made either by the sharp mandibles or by the still sharper sting, is composed mainly of formic acid, hence any fluid that will neutralize this acid is of benefit. If liquid ammonia can be had, this should be rubbed into the wound and all pain will cease very soon. In absence of this fluid, moist soil will give relief.

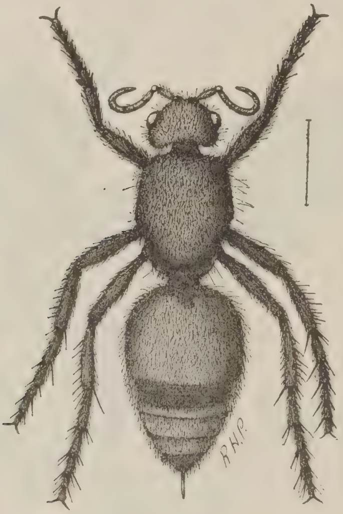


Fig. 171.—Cow-killer, female. Greatly enlarged. Original.

It is always best not to handle insects one does not know, no matter how innocent they may appear. For instance the insect illustrated in fig. 171, (*Sphærophthalma similima* Smith), which is so commonly seen running about sandy spots, should be left alone. Children are very apt to catch this prettily marked red and black insect, which resembles a large ant. If they should succeed they will be stung very severely, and may be sick for many days. This insect, or rather a larger southern species, has received the very appropriate name: "cow-killer," a name indicating its poisonous qualities.

II. INTERNAL PARASITES (*Entozoa*).

A. FIVE-MOUTHS.

(*Linguatulidæ.*)

Among the many parasites infesting man, domesticated animals, certain wild animals, and even amphibians, few are more degraded in consequence of a parasitic mode of life than the *Tongue-worm*, *Tonguelets* or *Five-mouths*. According to the careful researches of Leuckart these parasites are simply degraded mites forming the order *Linguatulidæ*. This comprises arthropods with elongated, worm-shaped and annulated bodies, possessing mouths without jaws, and which are surrounded by two pairs of hooks representing rudimentary legs. In the adults these parasites possess no hearts, and breathe through their skins. The annulated skin contains numerous glands of uncertain use. The ventral mouth, surrounded by a chitinous ring, opens into a central, straight, intestinal tube ending at the posterior end. The illustration (fig. 172) shows this peculiar parasite, and indicates also why it was not so very strange that formerly it was considered a tremadode-worm or a fluke. When young

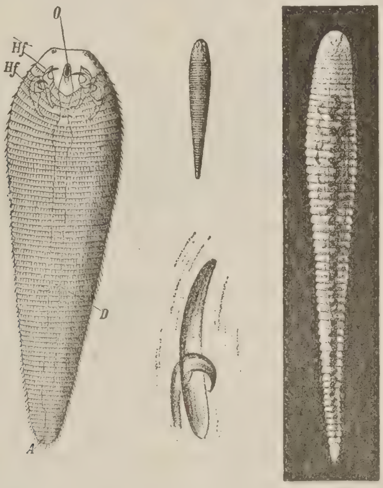


Fig. 172.—Five-mouth. To the left, secondary larva; in center, male, and below a single hook; to the right, a female. Greatly enlarged. After Brass.

the five-mouths resemble mites, and possess four legs, but when adult no external organs are visible except two pairs of small hooks on the head (*Hf*), a mouth (*o*), and two minute tactile organs at the anterior border. The hooks can be withdrawn into little sheaths or pockets, which, with the mouth, make five openings in the head, hence the name "Five-mouths." They possess no organs of vision. The sexes are separate; the grayish-white female, 7 to 10mm. long, is very much larger than the white male, which measures from 2 to 2.5mm.

The Tapeworm-shaped Five-mouth (*Linguatula* (*Pentastoma*) *tænioides*) is illustrated in fig. 172. The female deposits her eggs, about 500,000, in the nasal cavities of the dog, fox, wolf, and other carnivorous animals, whence they are expelled with mucus during the fits of sneezing caused by their presence, and in this manner they reach the surface of various low-growing plants or water. Protected by the mucus they keep alive for a number of weeks. If the plants coated with such eggs are eaten by any herbivorous animal, the mucus and egg-shells are dissolved, and the embryos, which were fully formed when the eggs were laid, are liberated in the intestines of the new host. The embryo is flat on the lower, round on the upper surface, and constricted and dentated at the posterior end. In this larval shape it bores through the walls of the digestive tube by means of a perforating apparatus formed by a style with two hooks, and thus reaches the liver, lungs, etc., where it becomes encysted. Here it gradually assumes the pupal shape. During the next five months a number of moults take place, and the body of this secondary larva becomes elongated, broader in front, and is divided into 80 to 90 segments, which possess a series of fine points on their posterior borders. (Fig. 172). Towards the seventh month these larvæ are completely developed, measuring from 6 to 8mm., and now leave their old home. Most of them die in their attempts to reach the nasal cavities of a new host, but some succeed. Dogs that eat the viscera of animals containing these parasites are certain to become infested with them. At all events the larvæ must reach respiratory organs to complete their growth, which they do by throwing off their old skins and replacing them with smooth and lancet-shaped new ones. The nomadic males are found not only in the nasal cavity, but also in the pharynx and larynx, while the females are less active. They are shown in position in fig. 173.

Generally speaking this parasite is not as common in the United States as it is in Europe. It has been found in the nasal cavities of the horse, mule, sheep, goat, hog and man. The actual and most natural hosts are the dog and the rabbit. If we prevent our dogs from eating the entrails of rabbits, sheep, etc., and do not permit them to visit slaughter-houses, there is little danger of an infection. To remove such parasites an injection of dilute ammonia, benzine, etc., is used; but in case of a valuable animal a veterinary surgeon should be consulted. Dogs infested rub their noses quite often, sneeze frequently, are easily excited, and become angry and bite. If numerous in the internal organs the parasites may cause death. The mature parasites cause, in man, bleeding of the nose, violent catarrh, and intensive headaches; those encysted in the liver cause other serious disturbances, and if they migrate, bleeding of the lungs, inflammation, and even death. Another species of Five-mouths is very common in Egypt, where it is found encysted in the livers of negroes.

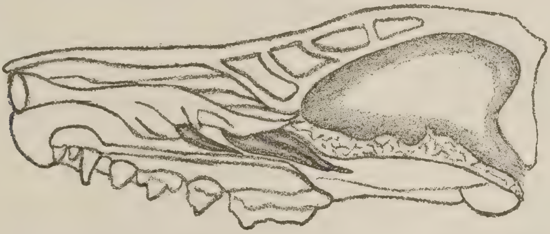


Fig. 173.—Three parasites in position in head of dog.

Children should never be permitted to kiss dogs!

B. BOT-FLIES. GAD-FLIES.

(*Œstridæ*).

The flies that belong to the above family are only parasitic in their larval state; the inactive pupal state is passed in the soil, and in the winged or adult form they fly about in search of quadrupeds upon which to deposit their eggs. In this winged state the flies are very active only during the warmer portion of the day and delight to bask in the sun, sitting upon some elevated rock or dead tree. Many species of Bot- or Gad-flies are known, each living, as a general rule, in its larval state in some particular animal, and usually even in a certain organ of that host. Man is not exempt, and in tropical America tumors caused by one or more species of such parasites are not uncommon. Even in more temperate regions such larvæ are found from time to time under the skin of man. Fig. 174 shows a larva of the Bot-fly of man (*Dermatobia noxialis* Goudot) taken from man. Dr. John Hamilton describes in the Entomological News a case that came under his observation. He writes:

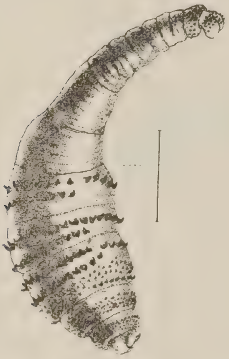


Fig. 174.—Bot-fly of man. Enlarged. After Brauer.

"Several years ago I saw, professionally, a boy six years of age who had been suffering for some months from the glands on one side of his neck being swollen and a fetid ulceration around the back teeth of the lower jaw of the same side. Three months treatment was of no avail, and the end seemed near; one day a white object which was seen to move, was observed in the ulcer at the root of the tongue, which on being carefully extracted proved to be a large grub, which, from having frequently seen them, I recognized as a full-grown larva of Hypoderma. It was of the usual tawny color, about half an inch long when contracted, about one-third that thickness, and quite lively. The case ended fatally. This boy had been on a farm in Illinois the previous fall, where probably the egg was in some way taken into his mouth, and the larva found between the base of the tongue and the jaw suitable tissue in which to develop, coming to maturity at the same time with those bred in cattle:

Bot-flies are stout and hairy insects, usually resembling bumble-bees. Their very small mouth has only abortive mouth-parts; the feelers are small and are almost hidden in little depressions or pits. The female fly differs from the male by possessing a more pointed abdomen, with a very extensive ovipositor. As is the case with most parasites a large number of eggs are deposited; the necessity for this is self-evident, as many of the young larvæ do not succeed in entering the host, but perish upon the way. In some cases the flies are viviparous, and bring forth the larvæ already hatched. The more mature larvæ or grubs are thick and fleshy; instead of feet they are provided with rows of hooks or spines, which they utilize in moving about. They breathe through one or two scaly plates at the end of the body. Those larvæ that live in the stomachs of their hosts have a mouth furnished with horny hooks, which they use to cling to the lining membrane; those, however, that live in tumors under the skin have no such hooks, but possess instead fleshy tubercles; they seem to live on the pus caused by their irritating presence. The younger larvæ are quite different from the older ones, and as most of them lead a different mode of life this is but natural. All these larvæ or grubs, when mature and ready to transform, leave their hosts, drop to the ground, and burrow in the soil, where they contract into peculiar puparia, inside of which the final changes take place. Because such grubs have to burrow in the soil few city-horses are troubled with bots, as the grubs which drop to the ground with the excrement can not burrow through the pavement, and are killed by exposure and by other means before they have found such a suitable shelter. Dr. Williston, our great authority on flies, has observed how the larvæ of Bot- and Warble-flies enter the ground, and how the latter leave the tumors they have produced. He writes in the Standard Natural History:

"They have the peculiar ability to contract either end into an elongate cylindrical form, which not only serves them in their egress, but also to bore into the ground. A few days before they are ready to emerge they begin to enlarge the opening by this expansion and contraction; when they have enlarged it sufficiently, a ring-like contraction of the body that begins at the posterior end and progresses toward the head enables them in a few minutes to free themselves, which they usually do in the morning hours. Upon the ground they creep about until they meet some obstruction, when they burrow from one to two inches below the surface, and remain as in the gastrophilus species."

The bot-flies which infest domesticated animals have been transported with their hosts to nearly all parts of the globe; others are found in wild animals. These flies can be divided into three groups, according to their mode of existence: 1, *Gastric*, or grubs that live in the stomach of their host; for example the Bot-flies of the horse (fig. 175). 2, *Cephalic*, or grubs that live in the nostrils and frontal sinuses of their host; for example, the Sheep Gad-fly (fig. 181). 3, *Cutaneous*, or grubs that cause and live in tumors just below the skin; for example the Ox Warble-fly (fig. 183).

The Bot-flies belonging to the genus *Gastrophilus* are well-known parasitic insects, most of which live in their larval stages in the stomach of horses. At least three species are found in Minnesota, but as all possess a very similar life-history only that of the best known species will be given.

THE COMMON BOT-FLY.

(*Gastrophilus equi* Fab.).

The illustration (fig. 175) shows this wooly insect which resembles in many ways a common honey-bee. It has a fawn-colored face, which is covered with a silky down; the thorax is covered with reddish hairs, and has, very frequently, a black transverse band. The abdomen is yellowish or reddish-brown with irregular darker spots; that of the female ends in a long ovipositor bent around, as seen to the left of the figure, while that of the male is obtuse. The wings in this species are transparent, and have near their middle a transverse smoky bar and two spots of the same color near the tip. The fly measures from 12 to 14mm.

During the whole summer these insects can be found, but principally during July and August, when the females are most active during the warmer part of the day; they may be seen buzzing about horses, asses and mules, balancing themselves in the air with the telescopic ovipositor directed downwards and forwards. When not disturbed by the animal the female deposits an egg upon those parts of the horse most accessible to that animal's tongue, or upon the fore-limbs, knees and shanks, and this operation is repeated so that many hundreds of eggs can be found upon the same animal. Horses in stables are not molested. The egg, one of which is shown on a hair in the illustration, is at first white, but soon becomes yellowish-white, is conical, about 1.25mm. long, finely transversely striated and provided at the upper end with a peculiar cap obliquely truncated. Such eggs are fastened to the hairs at their narrower end by means of a sticky material, which secures them so well in position that they can not be removed simply by brushing, as has been frequently stated. These eggs soon hatch, the time varying greatly according to the climatic conditions, into very active larvæ, which, crawling over the skin, cause an itching that induces the horse to lick such places. In some cases the eggs themselves are removed by licking, and thus reach the stomach; in other cases the very young larvæ crawl into the mouth, being enabled to do so by two black hooks in the head, which are bent almost at right angles. In this manner the larvæ reach the interior of the horse, where they fasten themselves to the mucous membrane of the stomach. This is accomplished by means of hooks found upon the head of the larvæ; the head gradually sinks

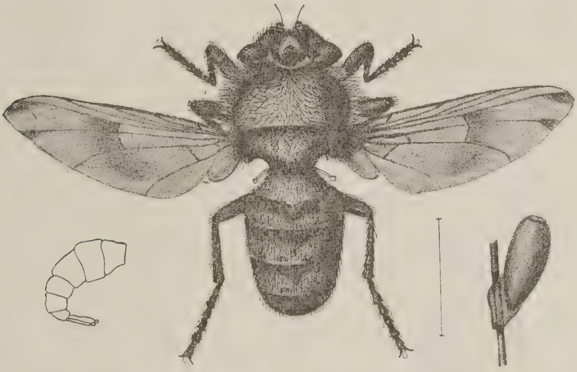


Fig. 175.—Bot-fly of horse; male; abdomen of female, and egg. Greatly enlarged. Original.

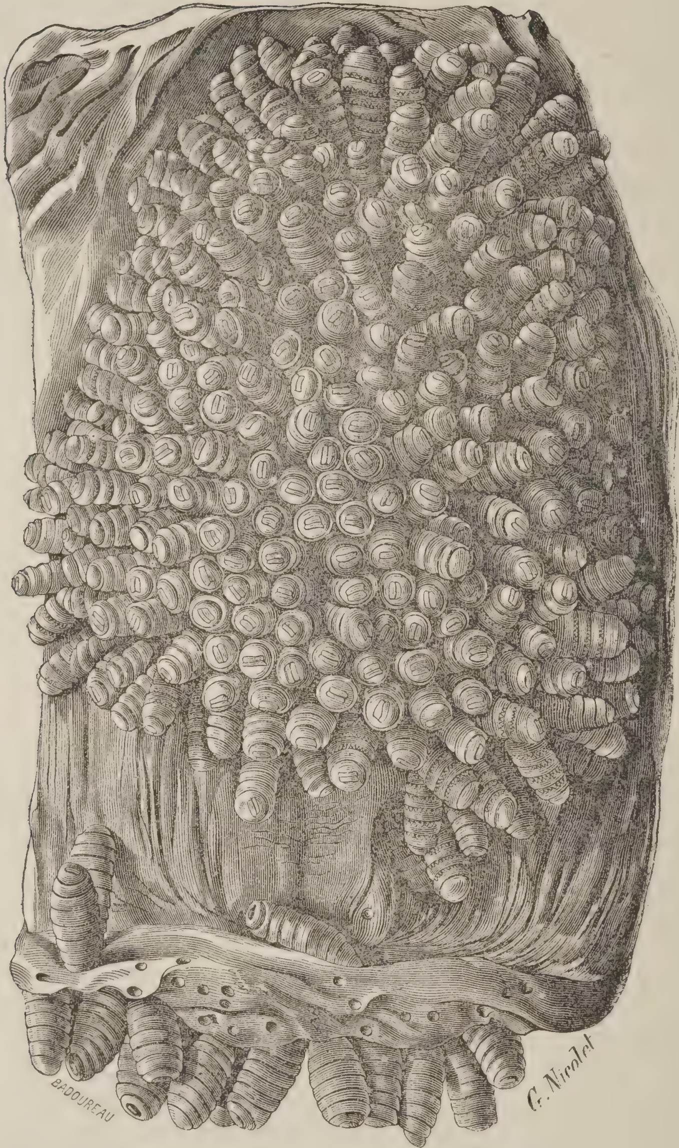


Fig. 176.—Bots in stomach of horse. Natural size. After Heller.

deeper and deeper into the alveolus that is formed under the influence of the irritation due to these hooks, and the products of the inflammation secreted by the small wound in the membrane furnish the food for these maggots or bots. Fig. 176 shows an infested stomach and also the numerous bots (as many as seven hundred have been counted in extreme cases), and the little pits produced by them. These bots are, when young, flesh-colored, later they are yellowish-brown.

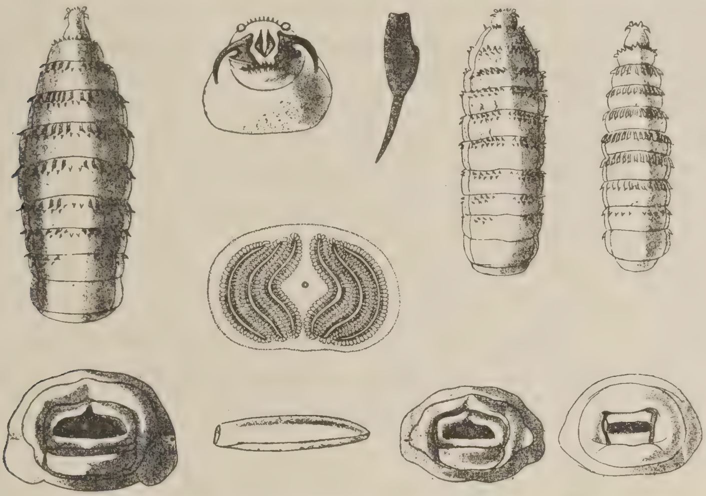


Fig. 177.—*Gastrophilus* larvæ; to the left *G. equi*; near middle *G. hæmorrhoidalis*; to the right, *G. nasalis;* below larvæ their last joints from behind. Enlarged. After Brauer.

The larva, after moulting twice, and changing from a very long and fusiform being into one shaped like those shown in the illustration, at last reaches its full size, which takes place after having been in the stomach of its host about ten months. It now detatches itself voluntarily, and passing along with the alimentary matters is finally expelled, and in this way reaches the ground. It is at this period still quite active and is enabled to penetrate the ground to a slight depth where it gradually becomes rigid and motionless. After one or two days its old larval skin assumes a bright brown color, which later becomes darker and darker; the skin hardens and shrinks a little, and gradually assumes the shape of a shining pupal-case, inside of which the true pupa is formed. The insects remain in this shape for about one month, when the mature winged and sexual flies force their way out of the old shell through an operculum, and enjoy for the first time after a long prison-life the light of day. To enable the flies to force their way out they possess a peculiar bladder-like organ on the front of the head, which, by inflation, swells up and thus can exert considerable pressure. It disappears when no longer needed.

In fig. 177 are shown the larvæ of our three bot-flies, as well as the hooks that enable them to fasten themselves to the mucous lining of the stomach, and the peculiar stigma at the end of the body, through which the insects obtain the necessary air.

THE RED-TAILED BOT-FLY.

(*Gastrophilus hæmorrhoidalis* Linn.).

This insect was captured upon a horse in St. Anthony Park, hence there is no doubt of its occurrence in Minnesota.

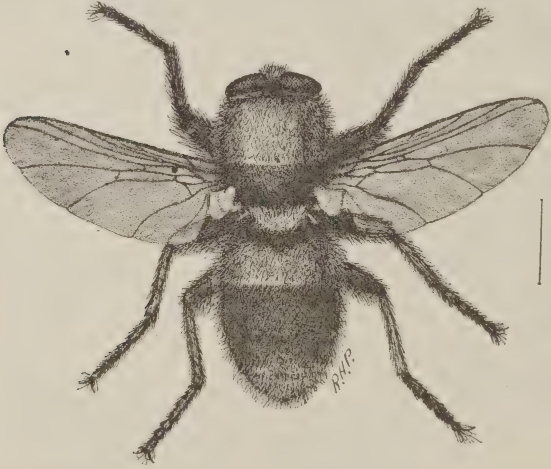


Fig. 178.—Red-tailed bot-fly. Greatly enlarged. Original.

The specimen, a male, is illustrated in fig. 178. It is at once distinguished from the above species by the absence of the black spots in the wings. The face is covered with light-colored hairs, the thorax is clothed with olive-gray hairs in front of the suture, and with black ones behind, which form a well-marked transverse band; the abdomen is covered with whitish hair in front, with black ones in the middle and with orange-colored ones behind. The fly is smaller than the one described before, measuring from 9 to 11mm. in length.

Judging from the description given of the habits of this fly it seems that they are almost identical with those of the larger bot-fly. It is stated that the female prefers to deposit her eggs on the lips of the horse, and on the long hairs covering them. This, of course, greatly irritates the animals, which is shown by their rubbing their lips against the ground, the fore-limbs, or trees. The eggs are said to be darker than those of *equi*. The adult larvæ are smaller and deeper red, and they have also the habit of remaining for some time in the folds of the rectal mucous membrane, where they assume a greenish color before leaving the infested animal. The young larvæ of this species may sometimes fasten to the epiglottis and in the pharynx, and thus can become dangerous to the horse.

THE NASAL BOT-FLY.

(*Gastrophilus nasalis* Linn.).

This species of bot-fly is illustrated in fig. 179. The upper surface of the thorax is clothed with dark hairs intermixed with others of a golden color; the anterior portion is much lighter colored, and fairly sharply separated from the darker posterior portion. The shining scutellum is of a dark-brown, bright-brown, or a chestnut color. The color of the dense hair covering the abdomen varies in the different specimens; in the example illustrated it is white on the second, black on the third, and orange on the last segments. The wings are hyaline, and small for the size of the fly, which measures from 12 to 13mm.

The elliptical white eggs are truncated in front, and are most frequently deposited upon the wings of the nose and on the lips of horses, hence the scientific name *nasalis*. Meigen and B. Clark designated this fly by such names as *salutaris* and *salutiferus*, to express the unfounded belief that the presence of such bots had a beneficial influence upon the digestive functions. The larvæ, when mature, are of a light-yellow color, with spines white at base and dark-brown at the tip. They are distinguished from the other bot-fly larvæ by having only one row of spines at the anterior border of their segments, of which the tenth one is unarmed. They are found only in the pyloric regions of the duodenum, and they do not fix themselves to the margin of the anus before being evacuated.

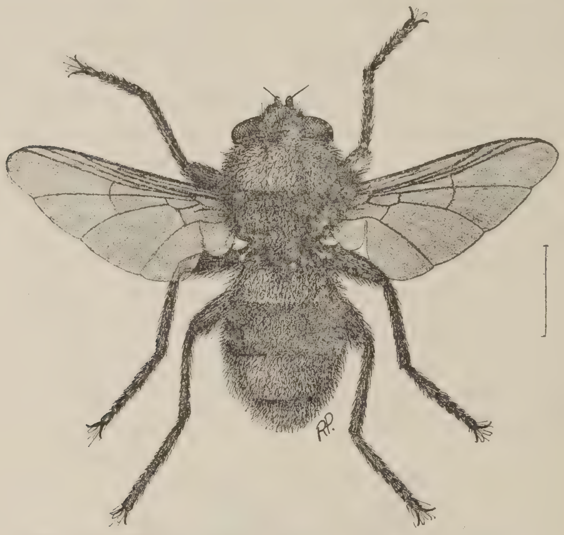


Fig. 179.—Nasal bot-fly. Greatly enlarged. Original.

If but few bots occur in the host they are harmless, but if very numerous they assuredly cause some pains, and in very extreme cases even colic; and where they penetrate through the mucous membrane into the body cavity, they cause violent inflammation and death.

Remedies: As these larvæ are exceedingly tough, and very difficult to kill even if immersed in fluids that would kill all other insects, and as they are well hidden in the stomachs of their hosts, all efforts to dislodge them are more or less useless. Still some veterinarians claim good results with such substances as Bryonia root, 15 to 20 grammes powdered and given in half a pint of water; or tar, 8 to 40 grammes in an aromatic infusion; or even benzine. An application of such substances may have good results, but an easy cure should not be expected. In fact Neumann arrived at this conclusion: "that agents endowed with great energy, and which arrive in the stomach without undergoing any modification, act upon that viscus, but scarcely produce any effect upon the larvæ. No medication can therefore be recommended for their destruction and expulsion." It is a very fortunate fact that they leave themselves without any medication, and that it is unnecessary to apply remedies unless the health of the animal is seriously endangered. If this should happen mucilaginous fluids should be given to allay the irritation, and the patient should be well fed to make up for the loss of nutriment caused by the bots. In the case of the *hæmorrhoidalis* larvæ in the rectal mucous membrane and the margin of the anus, they should be removed by hand, or by a weak emulsion of kerosene or benzine.

Prevention is the only true method we have to combat the various species of bots, and this is not a very difficult one. The eggs are readily seen, and should be removed as soon as seen. This seems to be simple, but it requires more labor than most people imagine. To simply use a brush, or a comb, is not sufficient, since they are so thoroughly well attached to the hair that a more heroic treatment has to be resorted to. The writer has found it best to paint the eggs with pure kerosene, and to do so every day, or whenever the horse has been out-doors. This oil will kill the eggs, which soon collapse and gradually disappear. With a little care the horse can be kept free of bots, which, even if they should be entirely harmless, are not a necessity to its well-being.

THE SHEEP GAD-FLY.

(*Œstrus ovis* Linn.).

This insect is a well-known parasite of the sheep and according to some authors, of the goat. It is the parent of the "Grub in the Head" and of the "False gid." As seen in the illustrations (figs. 180 and 181) it is a small fly, very rapid in all its actions, and one which when flying, is not readily detected, hence few persons have ever seen it, and judging from the fact that it is not represented in most of the larger collections in this country even entomologists have not frequently observed it. Fig. 181 was made by J. W. Folsom from a specimen in the Cambridge museum. It resembles a very large house-fly; the upper parts of the head and thorax are of a dull-yellow color and are covered with little elevated, round, black spots and still smaller brown specks. The five-jointed abdomen is velvety and variegated with brown and yellow colors; the feet are brown; the swollen underside of the head is white; the eyes are purplish-brown; three eyelets are found upon the top of the head, and two very minute feelers in front. As the fly possesses no mouth it can take no food; and it is only active during the warmer days of summer, when it attempts to deposit the young larvæ in the nostrils of sheep. Of course these larvæ come from eggs that were already hatched in the oviduct. Both sexes are nearly of the same size, measuring from 10 to 12mm. in length.

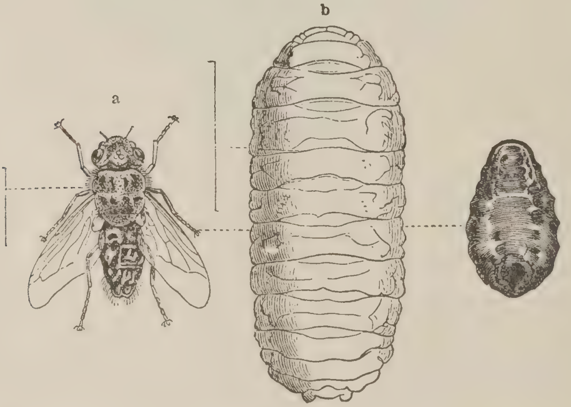


Fig. 180.—Sheep Gad-fly; *a*, adult; *b*, larva; *c*, puparium. After Brauer.

This parasite is found throughout Europe, Asia, Africa, and the Americas. Very likely it was introduced into the United States with the earliest flocks of sheep; more recently it has been introduced into Chili.

The Sheep Gad-fly flies only during dry and warm weather, from May to October; in cold and rainy days it hides near the sheep-folds and in other protected places. Like all flies of this order it delights to rest on warm and exposed rocks found in high elevations. The gravid female, approaching flocks of sheep, scares and disturbs them very greatly, and they try all sorts of ways to prevent it from depositing its young larvæ or maggots. The sheep lie down, bury their noses in the dust, huddle together, and even raise clouds of dust to deceive their enemy. But generally all their efforts prove of no avail. Just one hundred years ago Mr. Clark so well described the effects of an attack of the fly, that his words are repeated: "the moment the fly touches this part (the nose) of the sheep, they shake their heads and strike the ground violently with their fore-feet; at the same time holding their noses close to the earth, they run away, looking about them on every side to see if the fly pursues. They also "smell to the grass," as they go, lest one should be lying in wait for them. If they observe one, they gallop back, or take some other direction. As they can not, like the horses, take refuge in the water, they have recourse to a rut, or dry, dusty road, or gravel-pit, where they crowd together during the heat of the day, with their noses held close to the ground, which renders it difficult for the fly conveniently to get at the nostrils." As the gad-fly is only active during the warmer parts of the day the sheep can enjoy feeding early in the morning and late in the evening.

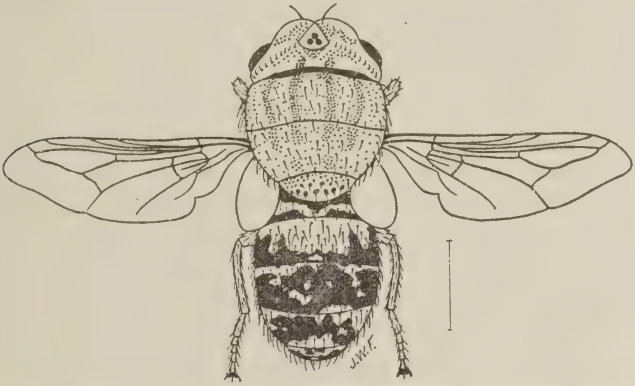


Fig. 181.—Sheep gad-fly from Cambridge Museum. Enlarged. Original.

The young grubs, as soon as they are deposited in the nostrils of the sheep, begin their migrations upwards into the dark passages of the nose and frontal sinuses. This movement is performed by means of hooks and spines, as the maggots do not possess any legs. Of course the use of such hooks and spines is very irritating to the sheep, and the poor victims make many attempts to get rid of their foes.

The grubs remain about ten months in the nasal cavities of the sheep. During this period they undergo a number of molts; in the first stage they are white and almost transparent, and measure about 2mm. in length; in the second stage they are 6mm. in length, yellowish-white, and have no spines except a few near the mouth. In the third stage the full size and form is attained as shown in fig. 180, *b*. When mature the larvæ detach themselves from the mucous membrane, creep about, reach the nose, and are expelled by the violent snorting of their host. A day later the larval skin, which was thus far soft and of a reddish color, becomes contracted, and gradually turns brown and black, forming a puparium inside of which the future fly is formed. This pupal stage lasts from four to six weeks. If many larvæ are present they cause in the sheep a catarrhal discharge on the affected side of the nose; this is commonly known as "Snot Nose." Neumann gives an excellent description of the symptoms: "Three or four larvæ of the *Œstrus* are frequently found in the frontal sinuses of sheep which, during life, have never manifested any symptoms. It is only when the larvæ are numerous, and when they are quite well advanced in their development at the commencement of spring-time, that they occasion morbid troubles. The latter begin by a discharge, often unilateral, which is at first clear and serous, then thick and mucous. Frequently there is sneezing and snorting, accompanied by the expulsion of mucus and sometimes of *Œstrus* larvæ. Later the animals turn the head backward, often shake it, rub the nose against the ground or some other object within reach, or with their front feet. As the malady gradually advances the sheep go with lowered head, lifting the feet high as if they were walking in water. Sometimes they quickly raise the head, carrying the nose to the wind, and then bend it backward convulsively. From time to time they stagger and are seized with vertigo, but do not turn in a circle. In severer cases there is difficulty of breathing, the first respiratory passages being obstructed by the larvæ or the inflammation of the mucous membrane. The eyes are red and watery. The disease may be still further complicated. The sick lose appetite and rapidly grow poor; they grate their teeth; a frothy saliva runs from the mouth; their eyes roll in the sockets; convulsions arise and finally death ensues sometimes within six or eight days after the appearance of the first symptoms.

"But the disease is rarely so fatal; it lasts longer, and the larvæ having been successfully cast out, the symptoms gradually become more favorable and by degrees completely disappear.

"This affection has sometimes been mistaken for "gid" or "turn-sick" due to *Cœnurus cerebralis*, whence the name "false gid" or vertigo of *Œstrus*, which has been given to it. Confusion will be avoided by recalling that turning in a circle does not take place in the present disease. The latter is nearly always accompanied by nasal discharges and snortings, which do not appear in true "gid," and which, besides, show themselves only in young subjects."

All interested in sheep husbandry should secure a copy of Dr. Cooper Curtice's book, "The Animal Parasites of Sheep." It was published by the Department of Agriculture in 1890, and is a very important document. In it are given a number of preventives, medicinal and surgical treatments, but the final conclusion is a quotation from Neumann, an advice sound to follow except in the case of breeders of valuable sheep. It is: "at all times, if the number of animals affected is considerable, the malady should be left to follow its own course, and those which present the gravest symptoms should be sent to the shambles."

Still there are a number of preventives and remedies that it is well to mention. Of course it is very doubtful whether remedies can reach larvæ hidden in the more remote cavities in the bones of the forehead and beneath the bases of the horns. When the grubs have entered the nostrils many can be dislodged and removed by a feather dipped in oil of turpentine, or a weak solution of carbolic acid, or of creosote. Salt water or diluted carbolic acid solution, injected with a syringe, does good service. Finely powdered lime is also used to cause violent sneezing, thus dislodging the larvæ. Some stock breeders smear the noses of their sheep with tar, or force them to do so themselves by attracting the animal to large auger-holes in logs baited with salt, and by coating the rims with tar; still others provide in the yards dry places covered with deep dust, into which the animals can thrust their noses if pursued by their tormenters. In a few cases the writer had an opportunity to use pyrethrum or Persian insect-powder. This material was blown forcibly into the nostrils of the sheep, and dislodged a number of the worms. It can also be used as an extract in alcohol, and will no doubt be very effective, as most dipterous larvæ are very sensitive in regard to this substance.

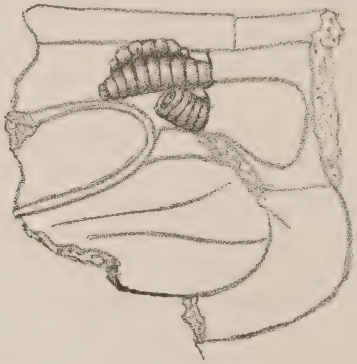


Fig. 182.–Three larvæ of sheep gad-flies in frontal sinuses of sheep. Enlarged. Orig.

The illustration (fig. 180) shows the different stages of this insect, and fig. 182 three larvæ in the frontal sinuses of a sheep.

There are a large number of bot-flies which exist in tumors they themselves have caused. The genus *Hypoderma* especially contains species that infest domesticated animals, hence these are best known; yet how little is really known about these parasites is indicated by the fact that until quite recently it was thought that the young larvæ forced their way directly through the skin into the host, instead of entering the mouth and thence making their way beneath the skin, where they are found in large tumors. Dr. Cooper Curtice was the first to draw the attention of entomologists to this fact. The life-history of these insects is about like this: the eggs are deposited by means of a horny and blunt tube, the ovipositor, which ends in a trifid tip, and shows by its structure that it could not be used to perforate a tough skin; this takes place early in the season, about the time when the cattle begin to shed their winter hair, and fore-legs, sides, belly and heels are selected for this purpose. The eggs are glued to the hairs in a similar manner as was described in other bot-flies. From here they are removed by the animals, which at this period are continually licking themselves to remove the old hairs. In this manner they reach the mouth, where the saliva rapidly dissolves the hard shells of the eggs and the young larvæ already formed inside are liberated. These young and spiny worms find their way down the gullet, and after boring through its walls, wander about in the tissues of the host; when they reach the skin they form the peculiar swellings known as warbles. Here they mature, and boring their way out, drop to the ground into which they enter, and where they contract into the dormant pupal stage. In about four weeks the winged insects appear, to start again a new cycle of life. The larval stage lasts from nine to ten months; during this period and especially while forcing their way through the tissues of the host, they cause inflammations and frequently injure the animals to such an extent that they lose flesh and become very poor. They cause a peculiar greenish and slimy discoloration and appearance of the flesh of their hosts, which is termed by the butchers: "licked beef;" when leaving the skin they produce holes in it called by tanners, "warbles."

These parasites are not common in Minnesota, hence we lose but little by their injuries. But a little further south they cause immense losses, which a Chicago newspaper, that made an investigation of the amount of damages caused by this fly in 1889, stated to be $3,337,565. This was for the markets of Chicago alone, so that the loss for the whole country must have been many times greater.

THE OX WARBLE-FLY.

(*Hypoderma bovis* DeGeer).

This species is the best known of all warble-flies and is the one most frequently described. Yet it seems doubtful whether it is found in the United States. The one that has been most usually mistaken for it is the following species.

THE STRIPED WARBLE-FLY OR HEEL-FLY.

(*Hypoderma lineata* Villers).

This species is illustrated in fig. 183. It is a very hairy insect, and characterized by four lines upon the thorax, which lines are by no means as well defined as some illustrations show them. It resembles a small black bee. The black and polished thorax is covered with yellowish-white hairs; the region about the scutellum is black, then follows a white band of hairs covering two rings of the abdomen, then a broad black band, while the posterior end is again whitish.

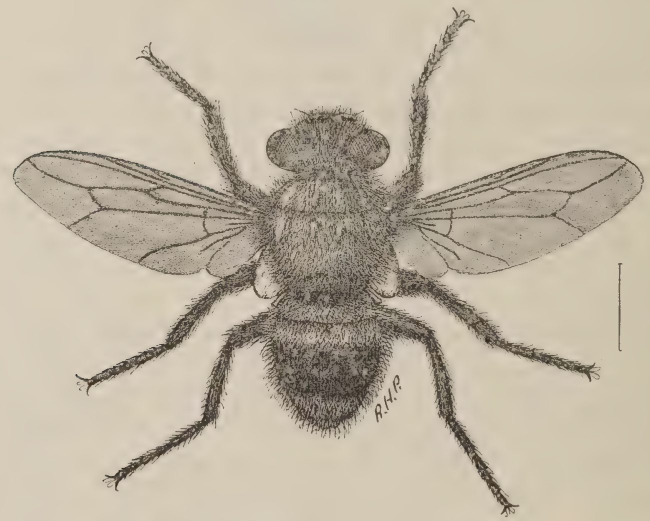


Fig. 183.—Heel-fly. Enlarged. Original.

REMEDIES.—Here again the best remedy is prevention. The eggs can be discovered without very much trouble, at least upon animals that are kept upon the farms. Of course cattle that have to take care of themselves all through the seasons, or in other words that are neglected, will not be benefited by any remedies and have to suffer unless we rub a mixture of pine-tar (1 gallon), kerosene, fish oil, or crude carbolic acid (1 quart), and powdered sulphur (2 pounds), over their sides, fore-legs, belly and roots of tail, which will protect them to some extent. This should be done at the time when they shed their old coats. Those animals that are kept upon the farm should be examined every day, and if any eggs are discovered they should be moistened with pure kerosene, which will kill the enclosed embryo. If such precautions have not been taken, and the tumors caused by the larvæ appear during January and February, they should be lanced, and the maggots should be removed by squeezing. By rubbing the wounds with a little carbolated vaseline they soon heal and disappear.

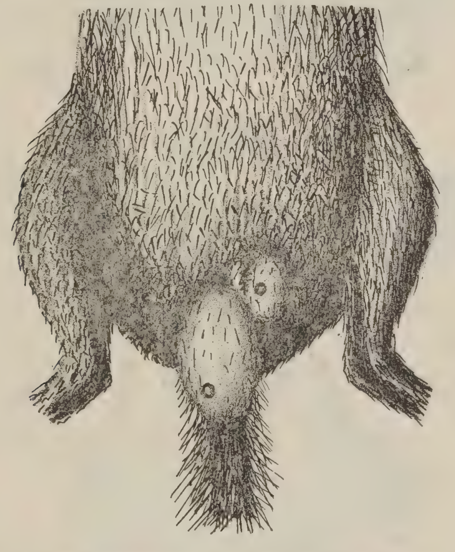


Fig. 184.—Larva of emasculating fly in striped gopher. Natural size. Original.

There is another genus of bot-flies, *Cuterebra*, that contains a number of very interesting flies, and as not infrequently letters are received asking for information in regard to some a few words about them will not come amiss, though these flies do not injure our domesticated animals. Fig. 184 explains itself. The host is a striped gopher, which harbored three of these bot-flies, two smaller ones and one almost fully grown. The tumors made by the large one and by one of the smaller ones are shown; they are under the skin and each communicates with the outside by means of an opening. Against these openings were pressed the anal ends of the larvæ, which contained the breathing-organs. The third larva was found in the neck of the gopher. The old story told by hunters that mature male squirrels are in the habit of emasculating the younger ones, for very selfish reasons, finds

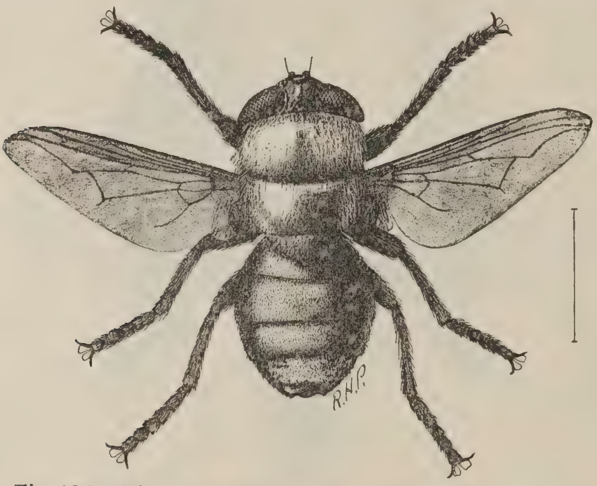


Fig. 185.—Adult of emasculating-fly. Enlarged. Original.

thus a more natural explanation. Some years ago the writer observed a fly belonging to the above genus leaving the burrow of a striped gopher. Though it is not wise to jump to conclusions, we may take it for granted that this fly is the adult of such emasculating bots. It is illustrated in fig. 185. As seen by the line giving the size of the insect it is a large fly, with a black face free from hair, large red eyes, a polished black thorax covered on the sides with long yellow hairs, the scutellum is covered with short black hairs, the abdomen is polished, of a dark steel-blue color, and sparsely covered with short black hair; only the penultimate segment has its anterior half covered with exceedingly short whitish hairs, in which are found a few spots showing the polished surface below. The legs are black and covered with short black hairs. As it does not agree with the description given of *Cuterebra emasculator* Fitch, it deserves a scientific name and C. *sterilator* is proposed for it.

Another large fly, illustrated in fig. 186, was captured in the prairie region of Minnesota; it seems to be *C. baccata*, an insect said to produce the large maggots found so frequently in the neck and other parts of our three species of hares. Fig. 187 shows a still larger fly, remarkable on account not only of its large size, but also of the dense yellowish-brown fur upon the thorax. It is *C. horripilum* of Clark. Still another species, entirely black, and almost as large as the fly shown above is found in our prairies. The history of all is obscure, and possibly a number of these flies

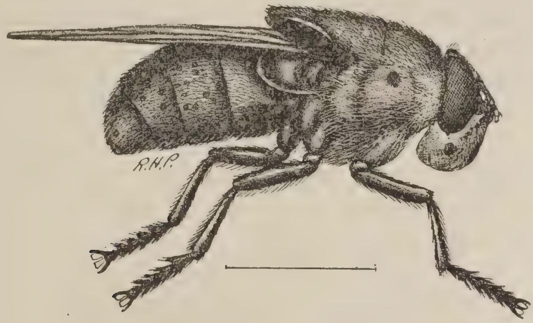


Fig. 186.—*Cuterebra baccata.* Enlarged. Original.

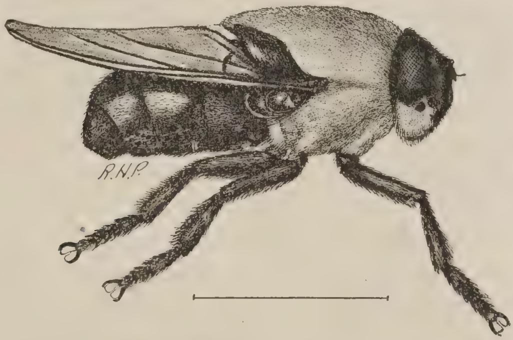


Fig. 187.—*Cuterebra horripilum* Clark. Enlarged. Original.

may cause the various tumors found in our rodents, such as the hares, squirrels, and gophers. The study of such flies is a very interesting one, but for many reasons one full of difficulties, apparently unsurmountable. Many interesting facts can still be discovered in this field, and it seems strange that thus far so very little has been done in tracing the life-histories of the American species of these insects.

Many other internal parasites are found in our domesticated animals, such as *Round-worms*, *Flat-worms*, *Leeches* and others, but to discuss and describe them, and to give the proper remedies, is the work of the veterinarian.

THE SNOW-FLY.

(*Chionea valga* Harr.).

It is the general opinion that with cold weather all insects disappear. This is true to a certain extent, yet there are a fairly large number of exceptions which are very interesting on account of being found at such times. As far as the globe has been explored in the north, just so far have insects been found, and not alone during summer and in well-sheltered spots but even in winter. The illustrations given in figs. 188 and 189 (plate XVI) show the male and female of a fly which is found in our state about Christmas, and as far as observed only after a fresh fall of snow. Owing to the whiteness of this material the insects are readily discovered, especially if they are moving about. As a general rule the wingless flies are found only early in the morning, though in one case a female was discovered crawling over the snow in the evening. As the illustrations show both males and females are entirely wingless and there is no trace left of the wings. The yellow halterers, however, are very large and prominent.

The insects move in a very deliberate way and are apparently not afraid of getting cold feet. As a general rule they are observed when the thermometer indicates the freezing point, though some have been found when it was below zero and the surface of the snow was frozen into a solid crust. The long legs of the insect are very slender and it is difficult to understand why the blood circulating in them does not freeze solid when exposed to such low temperatures, especially as the flies move so very slowly. In the illustration the legs are not drawn in a natural position as this would require altogether too much space. Notwithstanding the cold it is love that brings the sexes together at this time and if a female has been discovered on the snow we usually find a male not far away. A few winters ago the writer discovered a female moving slowly over the snow and by searching he soon detected a male. Putting both together under an inverted glass the snow-flies immediately mated, notwithstanding it was several degrees below the freezing point. Soon afterward the female found a crack in the glassy surface of the frozen snow, and forcing herself into it slowly disappeared from view. Penetrating to some depth into the snow she deposited a number of elongated eggs, which, however, did not hatch. Most females found seemed to have the eggs already fully matured and only lacked to be fertilized. In desspositing their eggs the female inserts them into some crack by means of a large ovipositor, very large for the size of the insect. The male also possesses some remarkable features and especially two powerful claspers at the end of the abdomen. Both sexes are shown, as well as some of their peculiar anatomical features.

INDEX.

Page.
Acanthia hirundinis 200
" *lectularia* 196
Acarus sacchari 88
Amblycera 109
American Harvest-mite 82
Anopheles quadrimaculatus 193
Anthrax alternata 21
Ants 205
" killing bedbugs 201
Apanteles congregatus 17
Aradus cinnamomeus 200
Army-worm 14
" -Erratic 20
Asilidæ 169
Ass—Biting-louse 113
Astoma muscarum 155
" *parasiticum* 155
Australian Dip 74
Bats infested by bed-bugs 199
Bed-bug 196
" infesting bats 199
" " chickens 199
" " pigeons 199
" " swallows 199
Benacus griseus 203
Bete-rouge 84
Biche 135
Big Bed-bug 207
Bird Itch-mites 78
" -tick 85
Biting-lice 46, 108
Biting-louse of ass 113
" " cat 111
" " cattle 113
" " dog 110
" " goat 115
" " horse 114
" " sheep 111
Black Breeze-fly 168
Black-heads 46

Page.
Black-flies 172
Black-fly Cream 182
Blister-beetles 204
Blood-sucking Cone-nose 207
  “ Corsair 201
  “ Oscinis 170
Blow-fly 155
Blue-bottle-fly 162
Boatman—Water 202
Body-louse of man 98
Bombylidæ 170
Boophilus bovis 91
Bot-flies 46, 209
  “ —Cephalic 212
  “ —Cutaneous 212
  “ —Gastric 212
Bot-fly—Common 212
  “ of horse 212
  “ —Nasal 217
  “ —Red-tailed 216
Burrowing-mites 52, 53
Cacœcia semiferana 31
California Dip 74
Calpocephalum 109
  “ *longicaudum* 127
Calliphora vomitoria 162
Campsomyia macellaria 158
Cat—Biting-louse 111
  “ —Demodex 48
  “ —Ear Itch-mite 78
  “ —Flea 133
  “ —Itch-mite 61
Cattle—Biting-louse 113
  “ -louse—Long-nosed 104
  “ “ —Short-nosed 102
Cattle-tick 91
Cecidomyia destructor 11
Celery Tree-hopper 37
Cephalic Bot-flies 212
Ceratopogon spec. 171
Chalepus trachypygus 26
Cheese-mites 87
Cheletus from ear of sailor 89
  “ “ human face 88
Chicken-mite or “Tick”. 85
  “ -scab 63

	Page.
Chickens—Feather-lice	118
" infested by bed-bugs	199
Chigoe	135
Chinch-bug in 1896	4
Chionea valga	230
Chique	135
Cholera and flies	151
Chorioptes	75
Chrysops æstuans	169
Cicadula 4-lineata	37
Clement's Dip	75
Coccotorus prunicida	38
Cœnurus cerebralis	223
Comedones	47
Common Bot-fly	212
" Hairy Rose-beetle	26
" House-fly	145
" Mange of horse	65
" Tick	92
Composition of Dips	73
Cone-nose—Blood-sucking	201
Conotrachelus nenuphar	41
Corsair—Two-spotted	207
Cow-killer	206
Crab-louse	100
Culex consobrinus	185
" *pungens*	194
Culicidæ	182
Curtice's Dip	74
Cutaneous Bot-flies	212
Cuterebra	227
" *baccata*	229
" *emasculator*	229
" *horripilum*	229
" *sterilator*	229
Demodecidæ	47
Demodex folliculorum	48
" " var. *canis*	48
" " " *cati*	48
" *phylloides suis*	48
Demodex of the cat	48
" " " dog	48
" " " hog	48
Dermacentor americanus	92

Page.

Dermanyssus avium 85
" *gallinæ* 85
" *hirundinis* 85
Dermatobia noxialis 210
Diplidium caninum 110
Dips—Australian 74
" —California 74
" —Clement's 75
" —Composition of 73
" —Curtis's 74
" —Kansas 74
" —Kerosene-emulsion 75
" —Law's 74
" —Mathew's 75
" —Nevada 74
" —Roloff's 75
" —Scheurle and Kehm's 75
" —Texas 74
" —Walz's 74
" —Zundel's 74
Diptera 46, 145
Docophorus 109
" *cygni* 122
" *icterodes* 121
Dog—Biting-louse 110
" —Demodex 48
" —Ear Itch-mite 77
" —Flea 133
" —Louse 106
" —Mange 61
Domestic Cricket 28
Doryphora decemlineata 27
Ducks—Feather-lice 121
Ear Itch-mite of cat 78
" " dog 78
" " ferret 78
Electric-light bug 203
Emasculating-flies 229
Empusa of fly 153
Entozoa 46, 207
Epizoa 46
Erratic Army-worm 20
Euphoria inda 26
Eupelmus allynii 12
Exorista leucaniæ 16
External parasites 46

Page.
Face-mite of man ... 48
Face-mites ... 46
False gid ... 219
Feather-lice ... 46, 108
  " infesting chicken ... 118
  " " duck ... 121
  " " geese ... 121
  " " guinea-fowl ... 127
  " " peacock ... 127
  " " pigeon ... 125
  " " swan ... 121
  " " turkey ... 127
Ferret—Ear Itch-mite ... 78
Five-mouths ... 46, 207
  " -Tapeworm-shaped ... 208
Flat-worms ... 230
Flea—Human ... 130
Flea of bat ... 138
  " cat ... 133
  " dog ... 133
  " hen ... 137
  " mouse ... 138
  " pigeon ... 137
  " pocket-gopher ... 138
  " rabbit ... 138
  " rat ... 138
  " shrew ... 138
Flea—Sand ... 135
Fleas ... 46, 129
Flesh-fly ... 155
Flies—Cholera and ... 151
Flies—Other ... 46, 145
Flour-mites ... 87
Fly-disease ... 151, 152
" —The Blow ... 155
" —The Flesh ... 155
" —The Stable ... 160
Foot-mange of horse ... 76
  " " sheep ... 76
Forest-fly ... 143
Frit-fly ... 6
Gad-flies ... 166, 209
Gad-fly of sheep ... 220
Gamasidæ ... 46, 84
Gamasus ... 85, 86
  " *pteropteroides* ... 87

Page.
Gastric Bot-flies 212
Gastrophilus equi 212
" *hæmorrhoidalis* 216, 219
" *nasalis* 217
" *salutaris* 217
" *salutiferus* 217
Geese—Feather-lice 121
Giant Water-bug 203
Gid 223
Glossina morsitans 162
Goat—Biting-louse 115
" -louse 104
Goniocotes 109
" *abdominalis* 118
" *burnettii* 119
" *compar* 125
" *hologaster* 118
" *rectangulatus* 127
Goniodes 109
" *damicornis* 126
" *dissimilis* 119
" *falcicornis* 127
" *minor* 126
" *numidianus* 128
" *stylifer* 128
Grape-vine leaf-hoppers 33
Gray-backs 99
Green-heads 168
Grocer's Itch 88
Grossbeak—Louse-fly 144
Grub in the head 219
Gryllus domesticus 28
Guinea-fowl—Feather-lice 127
Hæmatobia serrata 162
Hæmatopinus asini 102
" *eurysternus* 102
" *macrocephalus* 102
" *ovis* 105
" *piliferus* 106
" *stenopsis* 104
" *urius* 101
" *vituli* 104
Hair-lice 46, 108
Harvest-bugs 46, 80, 81
Harvest-mite—American 82
" —European 83

Page.
Harvest-mites—Irritating 82
Harvest-mites 46, 80, 82
Head-louse of man 97
Head-scab of sheep 60
Heel-fly 226
Hemiptera 46, 195
Hen-flea 137
Hessian-fly 11
Hippobosca equina 143
Hippoboscidæ 46, 139
Hog—Demodex of 48
" -louse 100
" —Scab of 58
Horn-fly 162
Horse—Biting-louse 113, 114
" -louse 102
" —Foot-mange 76
" -mange 53, 59, 65
" -tick 143
House-fly—The common 145
Human flea 131
Hypoderma bovis 226
" *lineata* 226
Insects injurious in 1896 3
Internal parasites 46, 207
Irritating Harvest-mite 82
Ischnocera 109
Itch-mite of dog—Ear- 77
" " man 54
Itch-mites 46, 50
" of birds 78
Itch-mite—Scale-bearing 58
" —The small 61
Ixodidæ 46, 89
Jigger-flea 137
Jiggers 46, 80, 81, 135
June-bugs 22
Kansas Dip 74
Kerosene-emulsion as a dip 75
Knemidokoptes viviparus 63
Lachnosterna rugosa 22, 24
" *tristis* 22
Læmophlœus fasciatus 204
Law's Dip 74
Leaf-hoppers—Grape-vine 33
Leaf-roller in 1896—Box-elder 31

Page.

Leeches........ 230
Leptus americanus........ 82
" *autumnalis*........ 83
" *irritans*........ 82
Leucania unipuncta........ 14
Lice—Hair- or Feather-........ 108
Lice—Sucking........ 94
Lilac-borer........ 38
Linguatula tænioides........ 208
Linguatulidæ........46, 207
Lipeurus anseris........ 123
" *baculus*........ 126
" *heterographus*........ 120
" *jejunus*........ 123
" *numidæ*........ 129
" *polytrapezius*........ 129
" *squalidus*........ 122
" *tadornæ*........ 122
" *variabilis*........ 120
Long-nosed Cattle-louse........ 104
Lopidea media........ 203
Louse-flies........46, 139
Louse-fly of grossbeak........ 144
Louse of cat—Biting........ 111
" " cattle— "........ 113
" " dog — "........ 110
" " goat — "........ 115
" " horse— "........ 114
" " horse and ass—Biting........ 113
" " sheep—Biting........ 111
" " dog —Sucking........ 106
" " hog — "........ 101
" " horse— "........ 102
" " man—Body........ 98
" " " —Crab........ 100
" " " —Head........ 97
" sheep—Sucking........ 105
" -Long-nosed Cattle-........ 104
" -Short-nosed "........ 102
Lucilia hominivora........ 159
" *macellaria*........ 158
Mallophaga........46, 108
Man—Body-louse........ 98
" —Crab-louse........ 100
" —Face-mite........ 48
" —Flea........ 130

Page.
Man—Head-louse 97
" —Itch-mite 54
" —Norwegian Itch-mite 58
Mange of dog 53, 61
" horse 53, 59, 65
" horse—Foot 76
" ox 66
" wolf 53
Mathew's Dip 75
May-beetles 22
Melophagus ovinus 141
Menopon 109
" *pallidum* 109, 120
" *phæstomum* 129
" *numidæ* 129
Merisus destructor 12
Meteorus vulgaris 21
Mite—American Harvest- 82
" —Chicken 85
" —European Harvest- 83
" —Irritating Harvest- 82
" —Burrowing 52, 53
" —Skin-eating Itch- 52
" —Sucking Itch- 53
Mosquitoes 182
Musca domestica 145
Myiasis 157
Myrmica scabrinodis 205
Nasal Bot-fly 217
Nematodes in fly 155
Nevada Dip 74
Noctua fennica 20
Notonecta undulata 202
Norwegian Itch-mite of man 58
No-see-um 171
Œstridæ 46, 210
Œstrus ovis 219
Ophion purgatum 17
Ornithobius 109
" *cygni* 123
Oscinis pallipis 170
" *soror* 6
Ox—Mange of 66
" —Warble-fly 226
Parasites of man and domesticated animals 44
Peacock—Featherlice of 127

Page.

Pediculi ... 46, 94
Pediculus capitis ... 97
" *vestimenti* ... 98
Pentastoma tænioides ... 208
Pettit—Report of ... 34
Phthiriasis ... 99, 101
Phthirius inguinalis ... 100
" *pubis* ... 100
Pigeon—Feather-lice of ... 125
Pigeons attacked by bed-bugs ... 199
Pique ... 135
Pirate-bug ... 201
Plum-curculio ... 41
" -gouger ... 38
Pocket-gopher—Tick ... 94
Polygnotus hiemalis ... 13
Potato-beetle ... 27
Psilocephala hæmorrhoidalis ... 21
Psoroptes ... 52, 64
" *communis* ... 65
" " var. *bovis* ... 66
" " " *equi* ... 65
" " " *ovis* ... 66
Pulex avium ... 137
" *irritans* ... 130
" *serraticeps* ... 133
Pulicidæ ... 129
Punkie ... 171
Pupipara ... 139
Rabbits—Itch-mite ... 61
Red-bugs ... 81
Red-tailed Bot-fly ... 216
"Red water" disease ... 91
Reinwardt's Breeze-fly ... 166
Remedies against biting-lice ... 117
" " bot-flies ... 218
" " cattle-tick ... 92
" " chicken-mites ... 86
" " chicken-scab ... 64
" " common mange of horse ... 66
" " common sheep-scab ... 71
" " ear itch-mite of dog ... 77
" " face-mites ... 49
" " fleas ... 135
" " harvest-mites ... 82
" " head-scab of sheep ... 60

Page.
Remedies against itch-mite of man.......... 56
“ “ lice.......... 107
“ “ mange of the horse.......... 59
“ “ “ “ “ ox.......... 66
“ “ sheep-ticks.......... 143
“ “ small itch-mite.......... 62
“ “ sucking-lice.......... 106
“ “ warble-flies.......... 226
Report of R. H. Pettit.......... 34
Roloff's Dip.......... 75
Rose-beetle—The common hairy.......... 26
Round-worms.......... 230
Sand-flea.......... 135
Sarcophaga carnaria.......... 155
“ *latifrons*.......... 158
Sarcopsylla gallinacea.......... 137
“ *penetrans*.......... 135
Sarcoptes.......... 52, 53
“ *cati*.......... 61
“ *crustosæ*.......... 58
“ *cuniculi*.......... 61
“ —*minor*.......... 53, 61
“ —*mutans*.......... 63
“ —*scabiei*.......... 53
“ “ var. *canis*.......... 53, 61
“ “ “ *capræ*.......... 53
“ “ “ *equi*.......... 53, 59
“ “ “ *hominis*.......... 54
“ “ “ *lupi*.......... 53
“ “ “ *ovis*.......... 53, 60
“ “ “ *suis*.......... 53, 59
“ *squamiferus*.......... 59
Sarcoptidæ.......... 46, 50
Scab of chicken.......... 63
“ “ goat.......... 53
“ “ hog.......... 53, 5
“ “ sheep—Common.......... 66
“ “ “ —Foot-.......... 76
Scale-bearing Itch-mite.......... 58
Screw-worm.......... 158
Scheurle and Kehm's Dip.......... 75
Sesia syringæ.......... 38
Sheep—Biting-louse.......... 111
“ —Common-scab.......... 66
“ —Foot-scab.......... 76
“ —Gad-fly.......... 219

Page.
Sheep—Head-scab........ 60
" —Sucking-louse........ 105
" -tick........ 141
Short-nosed Cattle-louse........ 102
Simonea folliculorum........ 48
Siphonaptera........46, 129
Simulidæ........ 172
Simulium decorum........ 177
" *irritatum*........ 179
" *meridionale*........ 174
" *minutum*........ 176
" *tribulatum*........ 179
Skin-eating Itch-mites........52, 64
Snow-fly........ 230
Sphærophthalma similima........ 206
Spanish-flies........ 204
Sporendonema........ 153
Stable-fly........ 160
Stomoxys calcitrans........ 161
Striped Warble-fly........ 226
Sucking Itch-mites........ 53
Sucking-lice........ 46, 94
Swallows infested by bed-bugs........ 199
Swan—Feather-lice........ 121
Symbiotes........ 53, 75
" *auricularum*........ 75
" " var. *canis*........ 77
" *communis*........ 75
" " var. *equi*........ 76
" " " *ovis*........ 76
Symplectoptes cysticola........ 79
Tabanidæ........ 166
Tabanus atratus........ 168
" *lineola*........ 168
" *reinwardtii*........ 168
Tachina-fly of army-worm........ 16
Tænia cucumerina........ 110
" *solium*........ 165
Tapeworm........110, 165
Tapeworm-shaped Five-mouth........ 208
Tetranychus autumnalis........ 83
Texas Dip........ 74
" Fever........ 91
Tick—Cattle-........ 91
" —Common........ 92
" —Chicken-mite or........ 85

Page.
Tick—Pocket-gopher 94
Tick-seed 83, 94
Ticks 46, 89
Tonguelets 207
Tongue-worms 207
Tree-hopper—Celery 37
“ “ —Grape-vine 33
Trichodectes 109
“ *climax* 115
“ *latus* 110
“ *limbatus* 115
“ *parumpilosus* 114
“ *pilosus* 113
“ *scalaris* 113
“ *sphærocephalus* 111
“ *subrostatus* 111
Tricocephalus dispar 165
Trinotum 109
“ *conspurcatum* 124
“ *lituratum* 124
“ *luridum* 124
Trombidiidæ 46, 80
Trombidium locustarum 80
“ *muscarum* 80
Tsetse-fly 161
Turkey—Feather-lice 127
Two-spotted Corsair 101
Typhlocyba comes 34
“ *vulneata* 34
Tyroglyphus longior 87
“ *sacchari* 88
Warble-fly—The Ox 226
“ —Striped 252
Walz’s Dip 74
Water Boatman 202
Wheat-stem maggot 10
White-grubs 22
Zundel’s Dip 74

PLATE I.

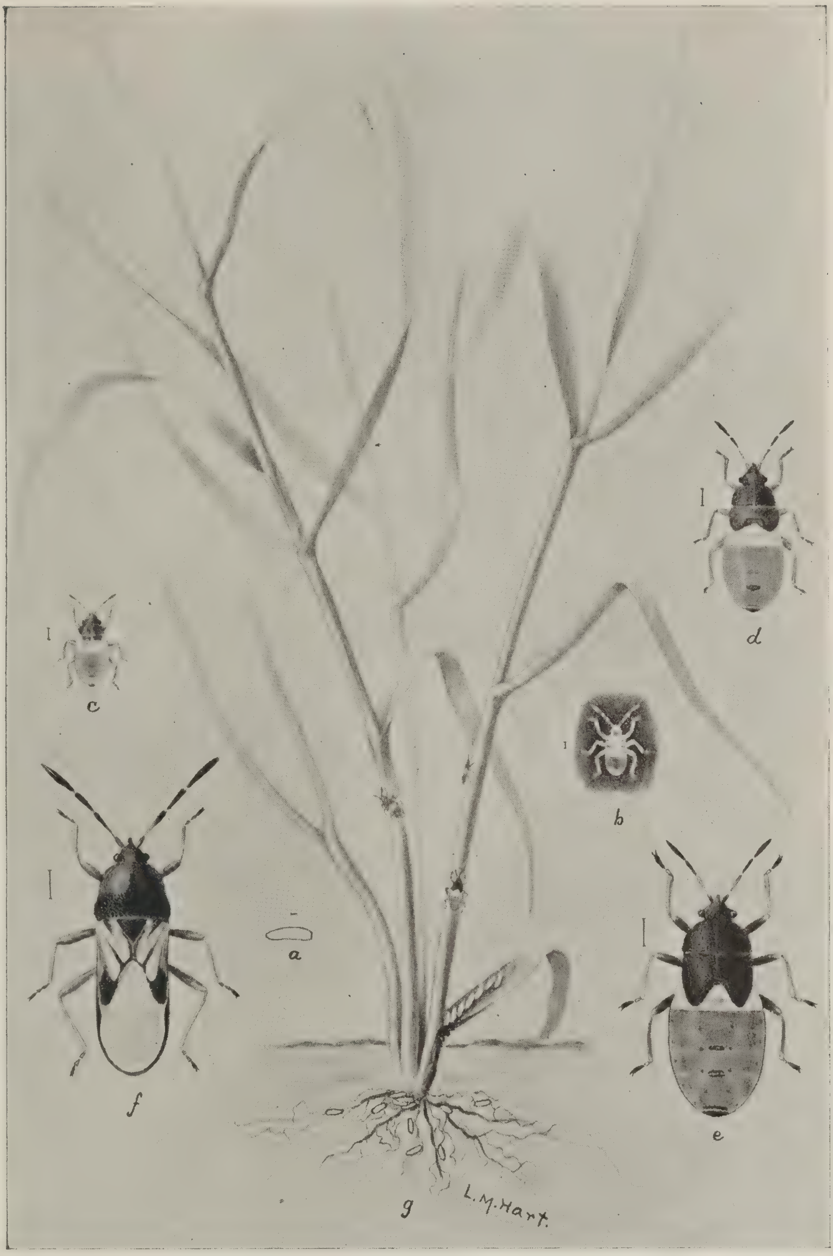
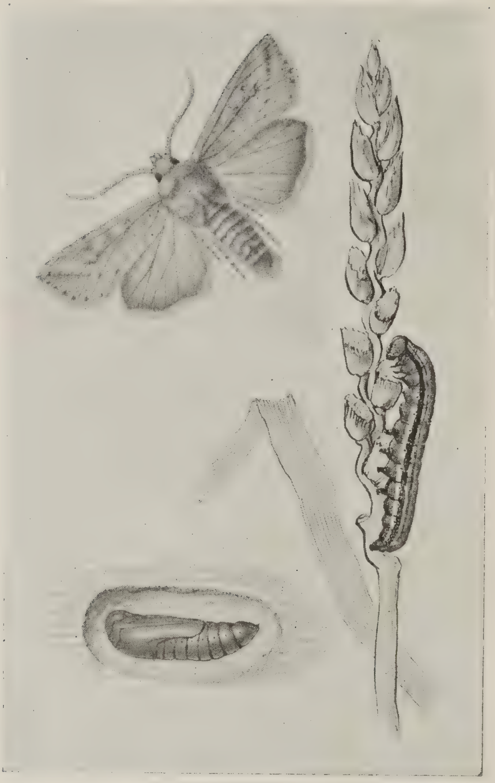


FIG. 1.

PLATE II.



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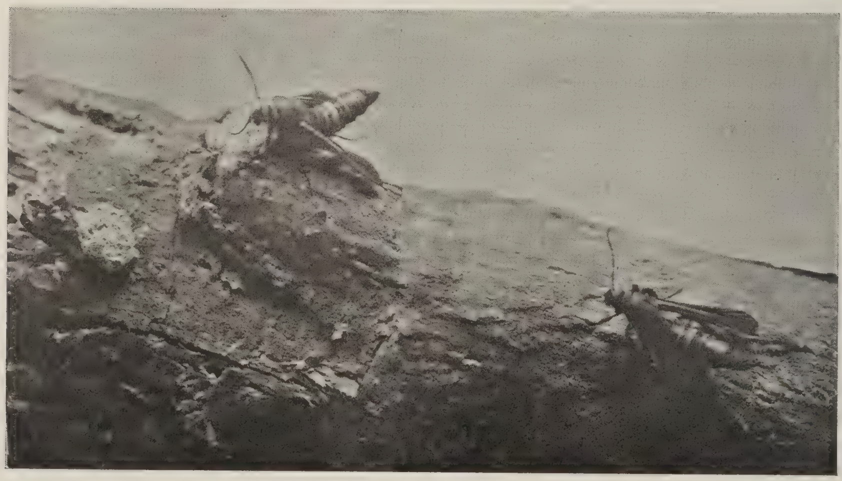
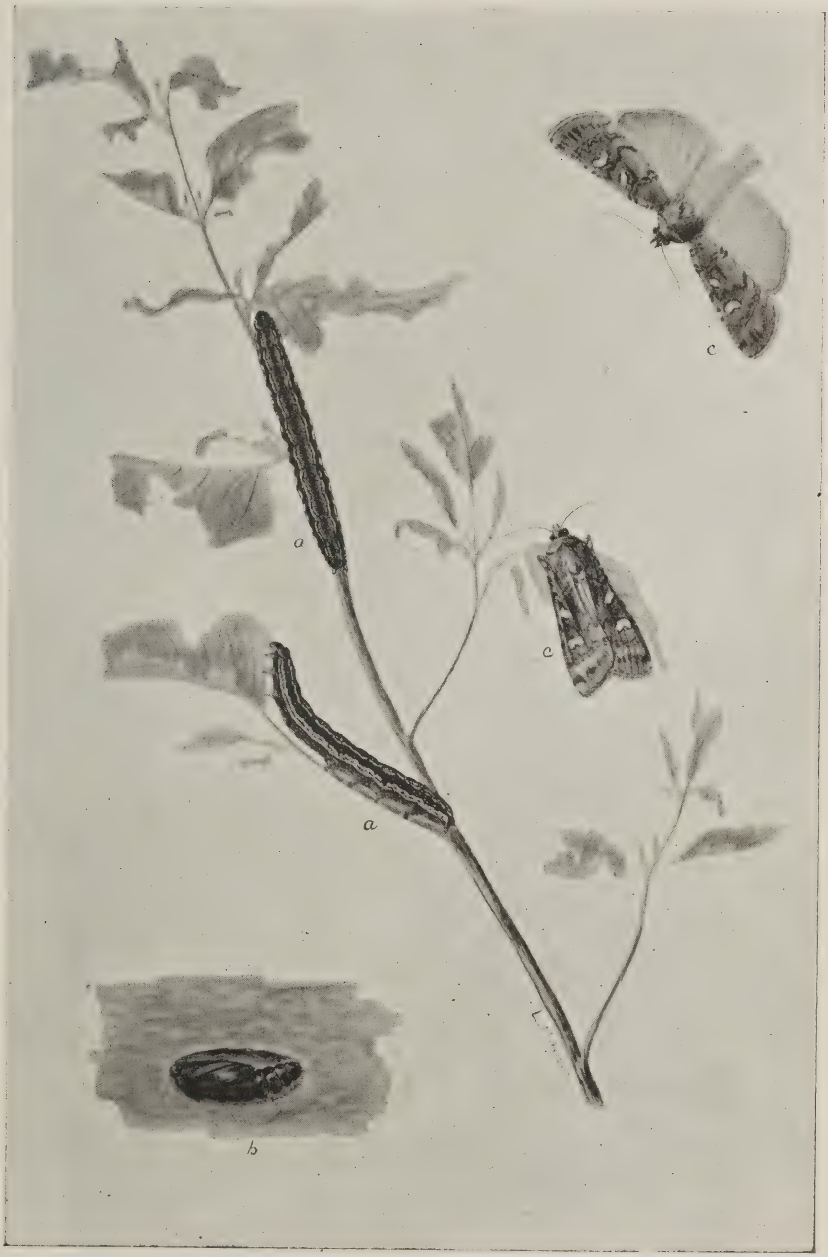


FIG. 21.

PLATE III.



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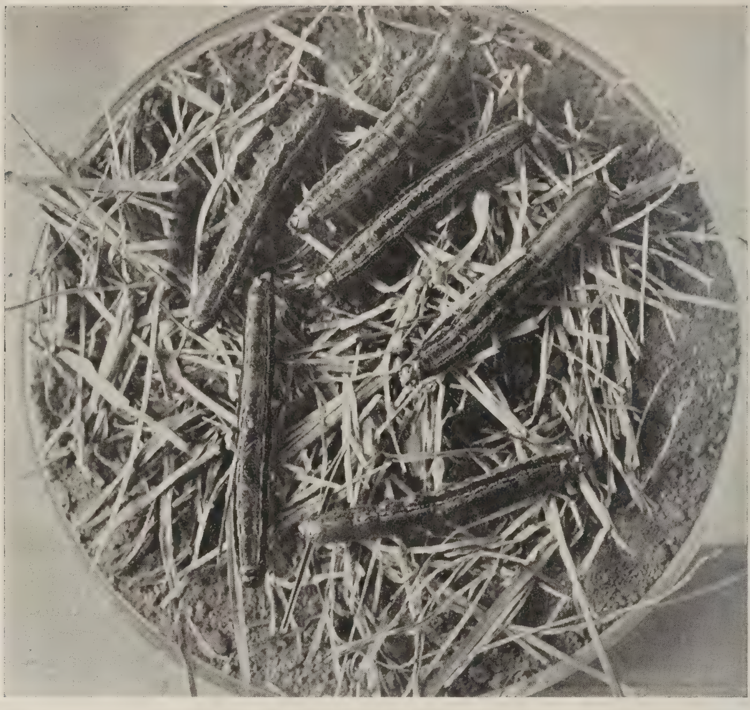

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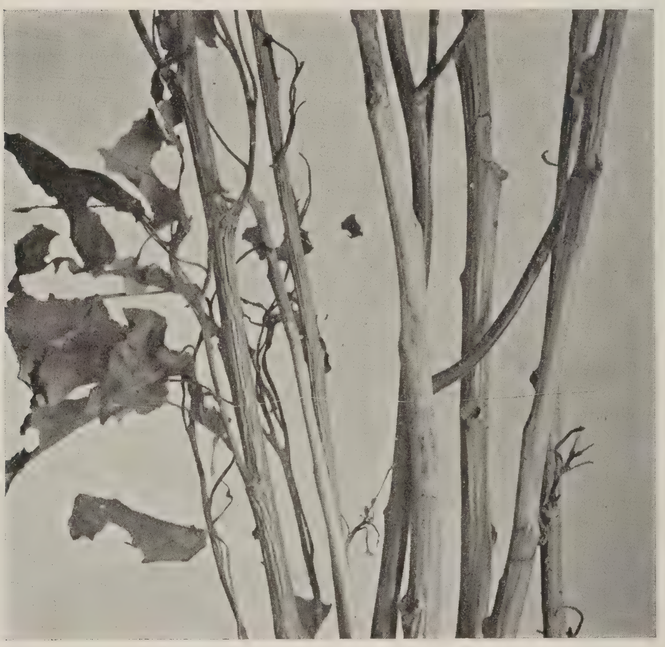
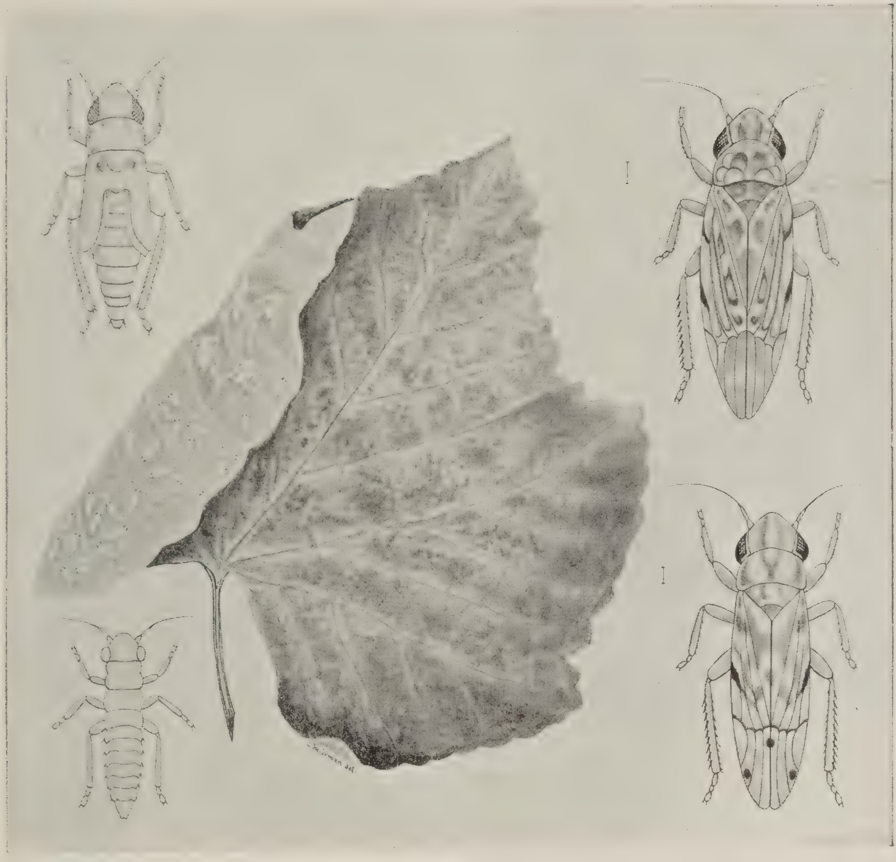


FIG. 14.

PLATE V.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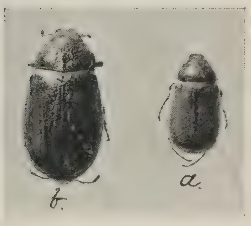

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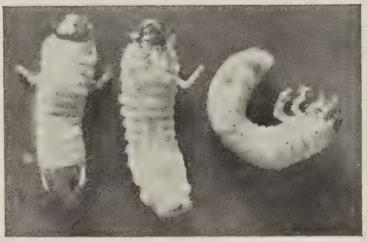
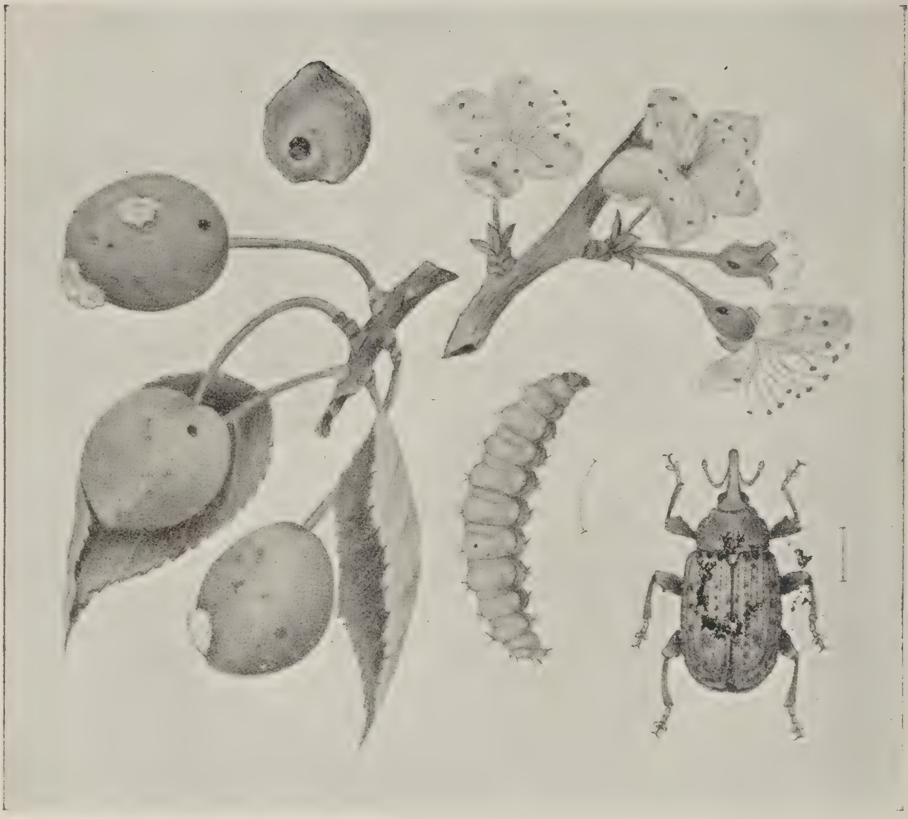


Fig. 16.

PLATE VI.



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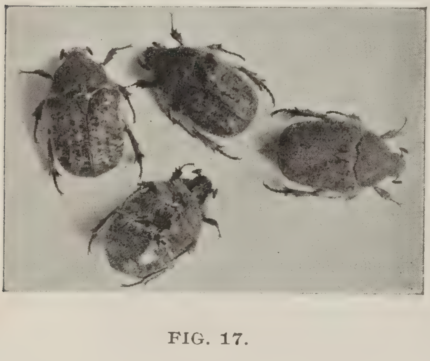

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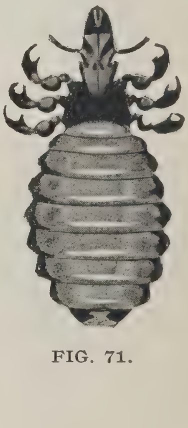
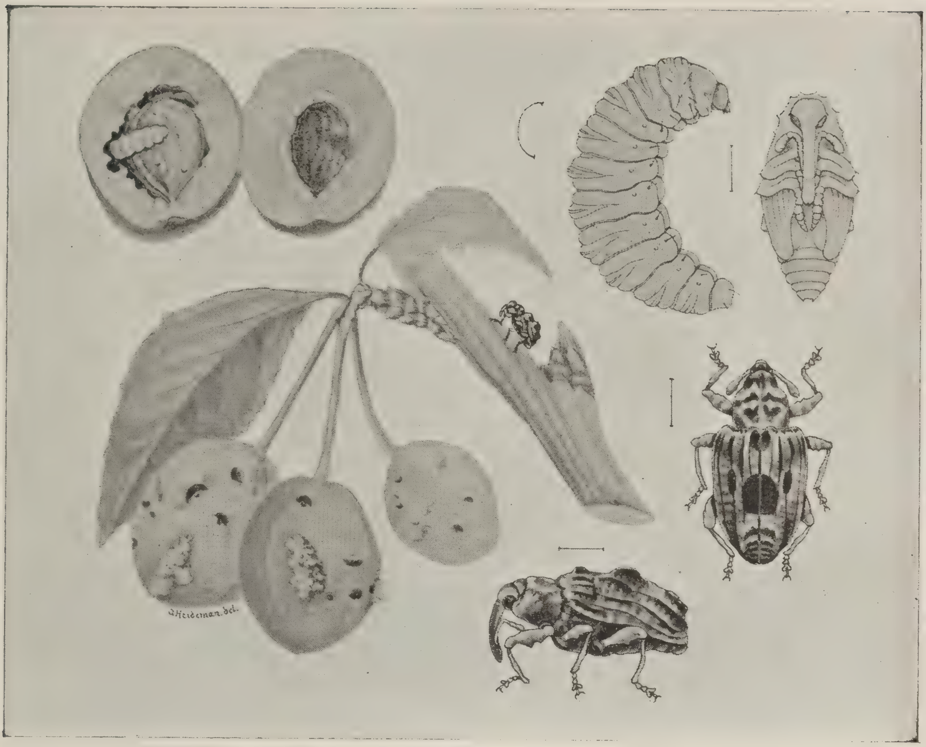


FIG. 71.

PLATE VII.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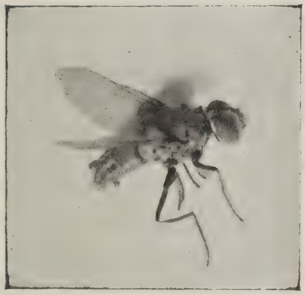

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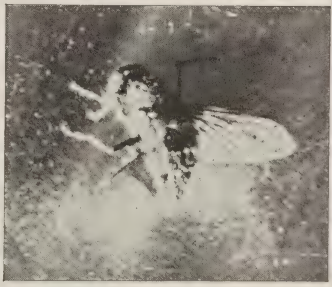
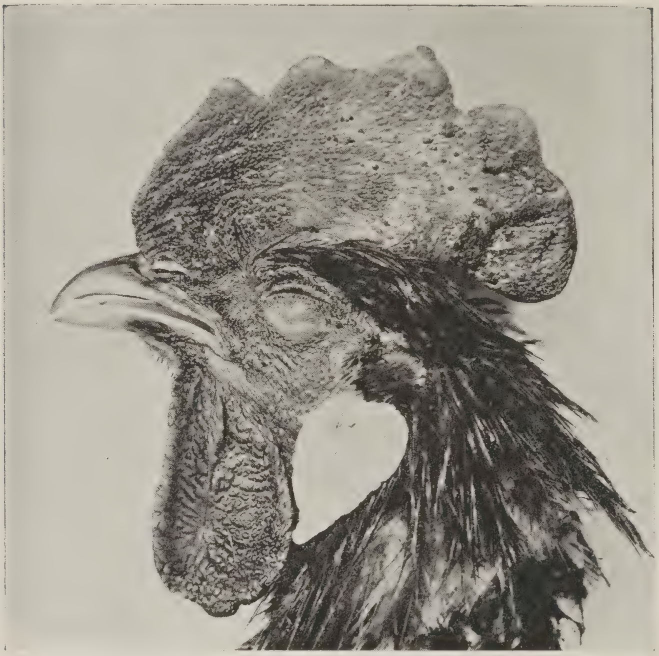


FIG. 128.

PLATE VIII.



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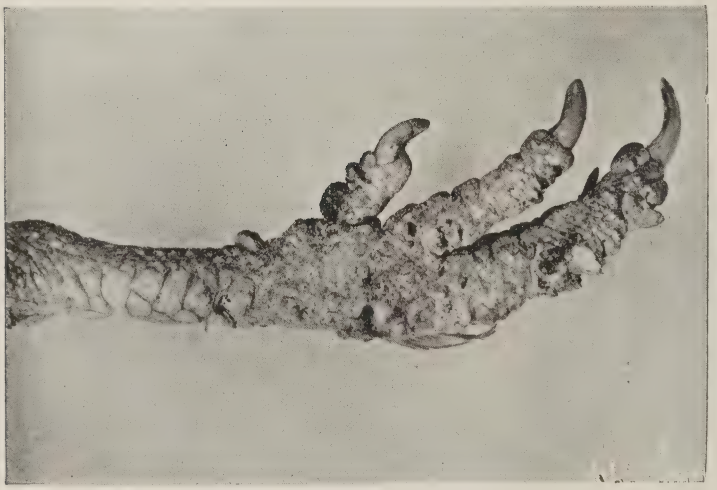


FIG. 35.

PLATE IX.

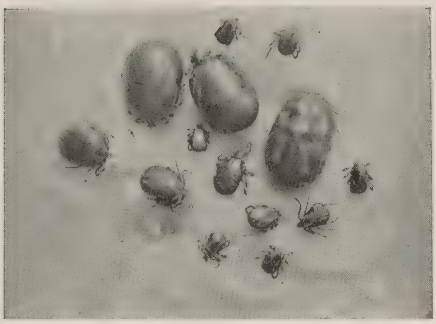


FIG. 55.

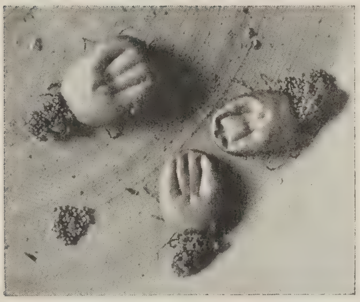


FIG. 58.

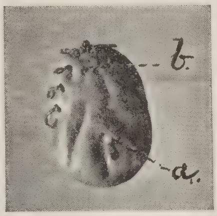


FIG. 59.

FIG. 60.

PLATE X.

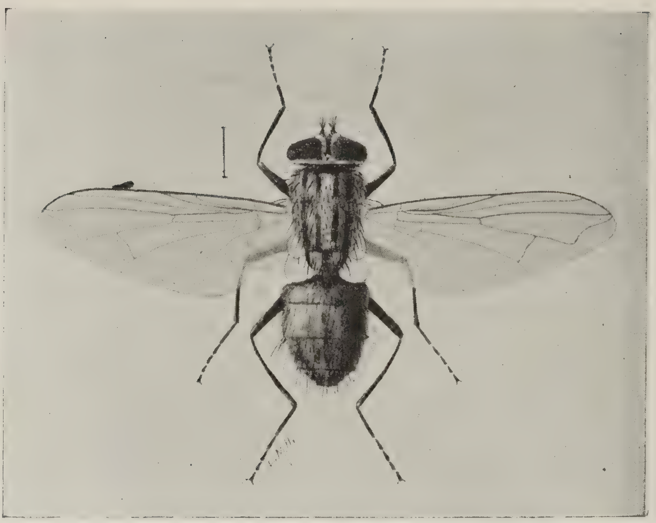


FIG. 125.

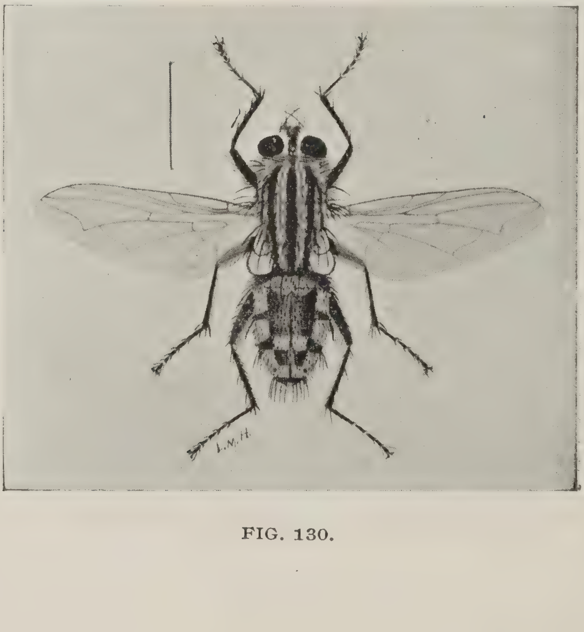


FIG. 130.

PLATE XI.

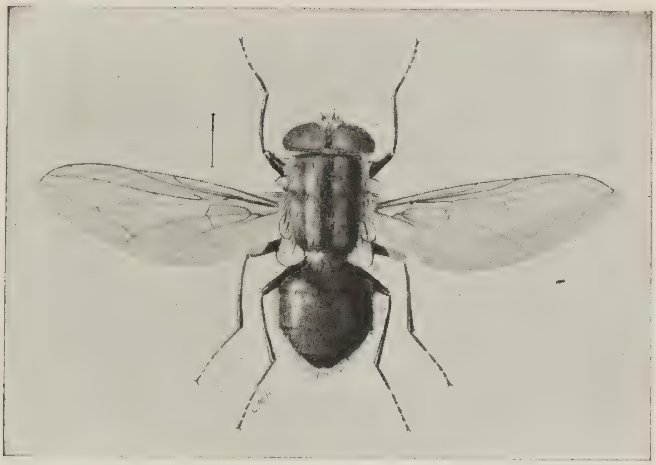


FIG. 131.

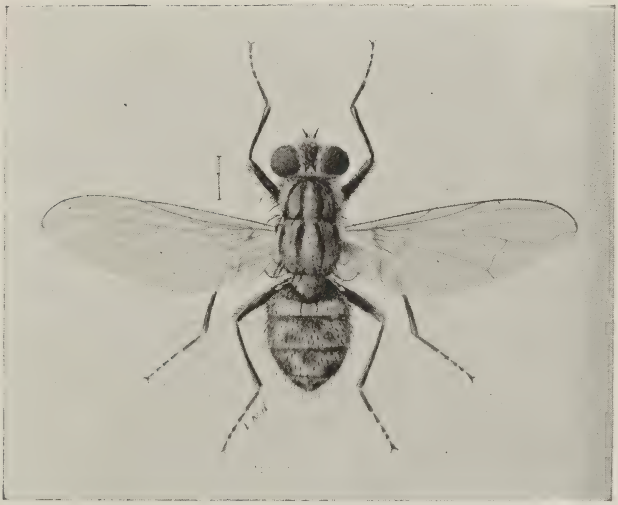


FIG. 132.

PLATE·XII.

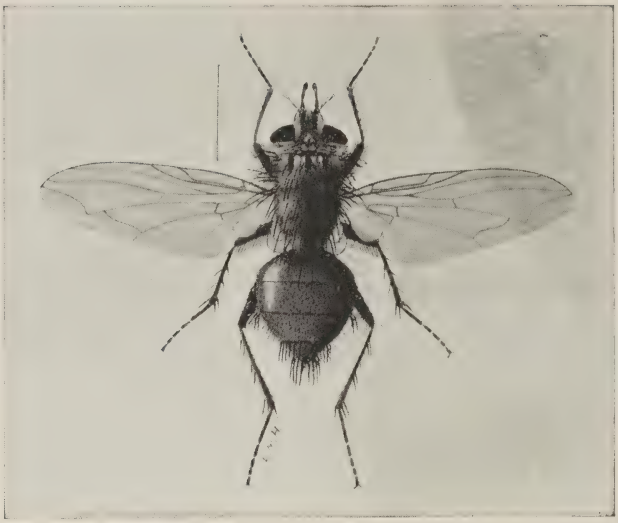


FIG. 135.

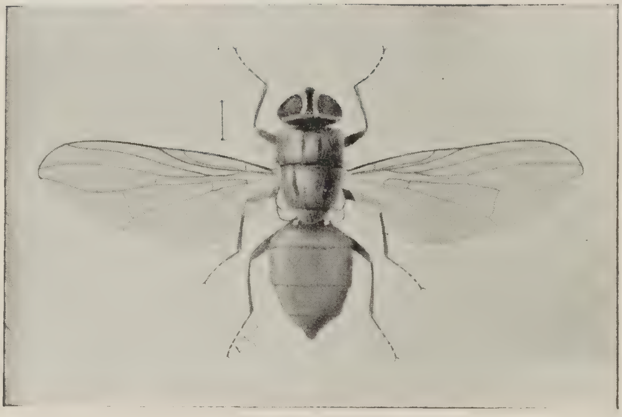


FIG. 136.

PLATE XIII.

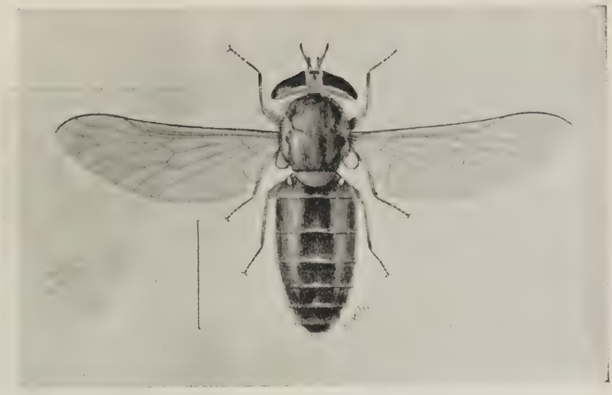


FIG. 139.

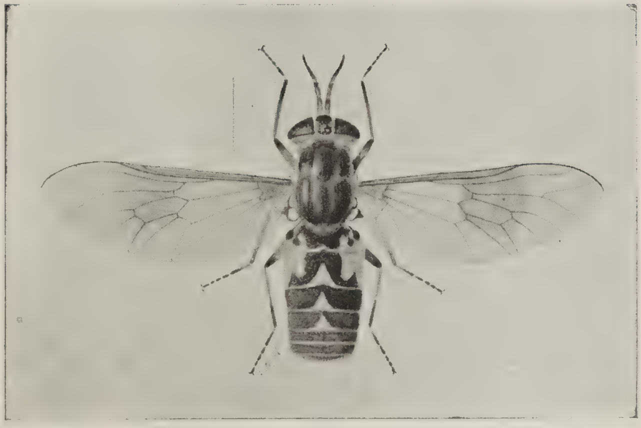
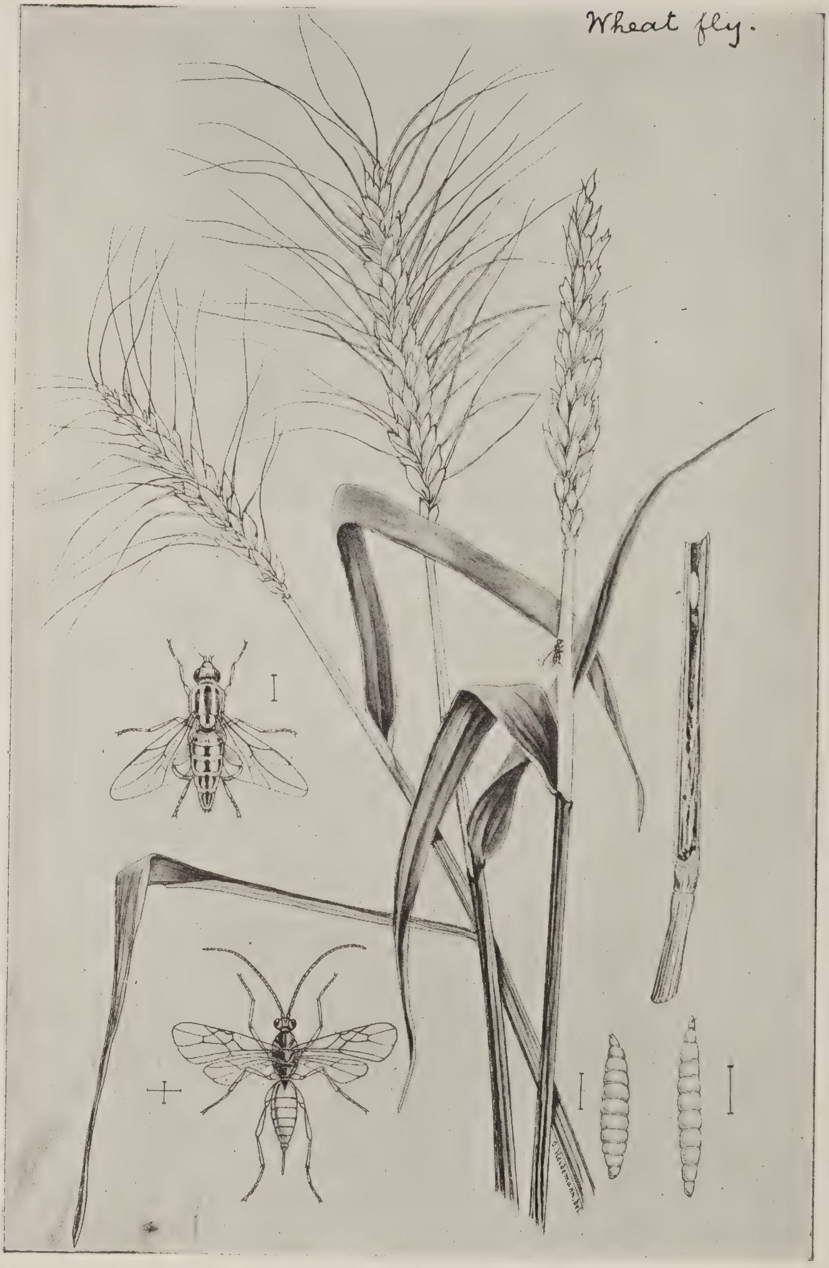


FIG. 140.

PLATE XIV.


C. Heidemann del.

Wheat fly.

PLATE XV.

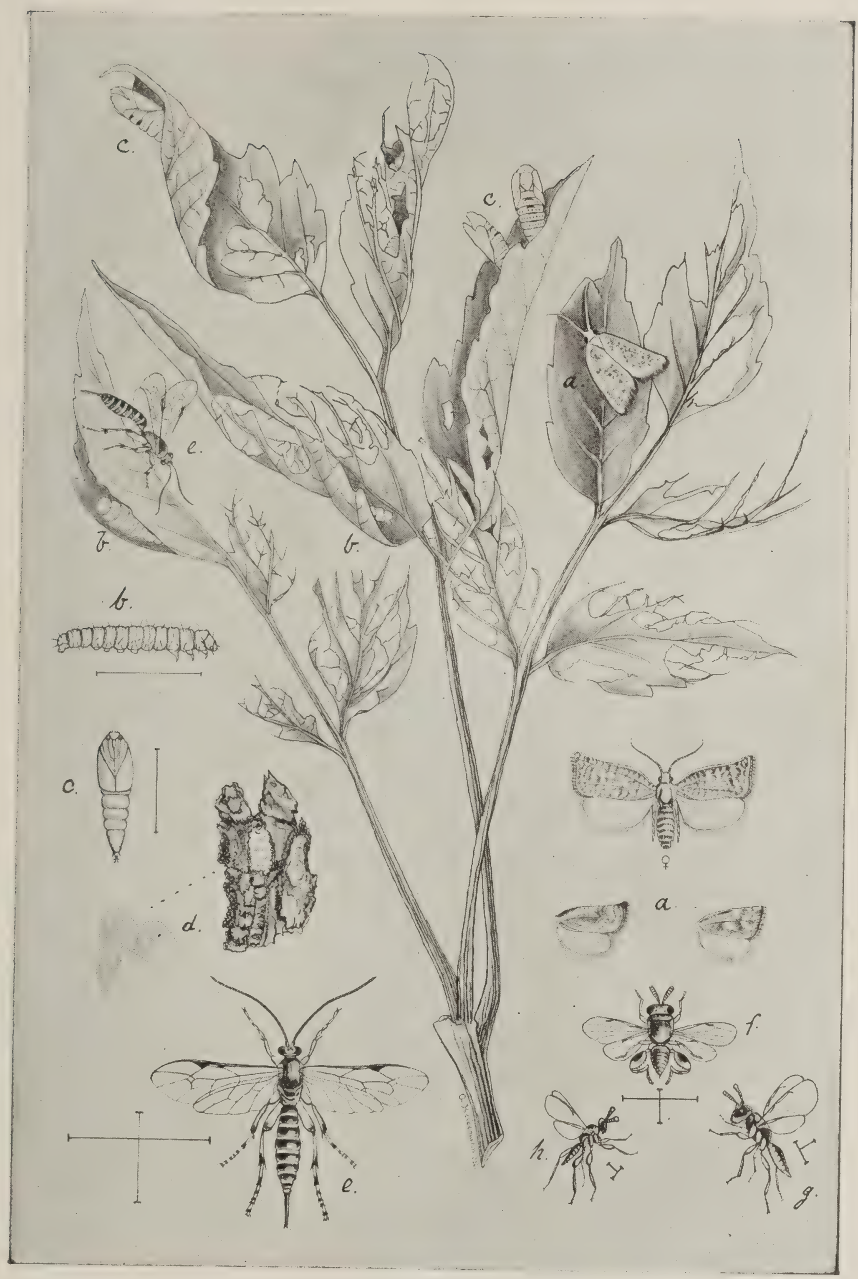


PLATE XVI.

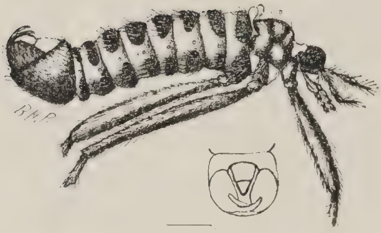


FIG. 188.

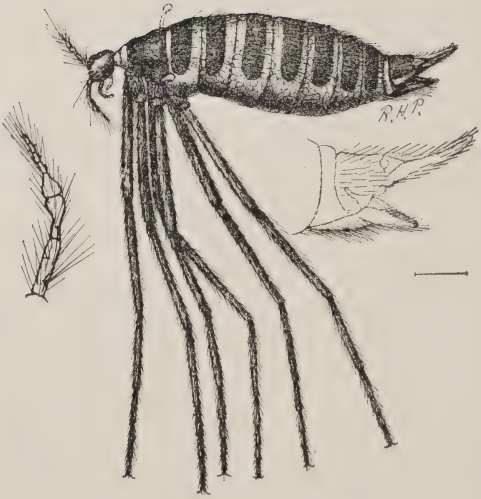


FIG. 189.

ERRATA.

Page 11, line 2, read *Cecidomyia* for *Cecidomia.*

Page 49, fig. 25 is upside down.

Page 79, under fig. 43, read original for origina .

Page 105, under fig. 75, read egg for gg.

Page 109, line 6 from bottom, read *Amblycera* for *Amblicera.*

Page 110, under fig. 78, read Biting-louse for Biting l use.

Page 120, line 8, read *Lipeurus* for *Lipeeurus.*

Page 126, line 4 from bottom, read *Lipeurus* for *Lipuerus.*

Page 176, line 2 from bottom, read fig. 143 for 145.

Page 178, line 3 from bottom, read 145 and 146 for 143 to 146.

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